Soil Survey

Series 1933, No. 23. Issued February 1939

Alfalfa County Oklahoma

By
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United States Department of Agriculture, in Charge
and
C. A. HOLLOPETER and R. E. PENN
Oklahoma Agricultural Experiment Station

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS
In cooperation with the
Oklahoma Agricultural Experiment Station

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SOIL SURVEY OF ALFALFA COUNTY, OKLAHOMA

By A. W. GOKE, United States Department of Agriculture, in Charge, and C. A. HOLLOPETER and R. E. PENN, Oklahoma Agricultural Experiment Station

COUNTY SURVEYED

Alfalfa County is in the northern part of Oklahoma (fig. 1), and its northern boundary coincides with the Kansas-Oklahoma State line. Cherokee, the county seat and largest town, is about 100 miles northwest of Oklahoma City. The county, which is quadrangular in shape, includes an area of 867 square miles, or 554,880 acres.

This county lies at the eastern edge of the region occupied by soils with a zone of carbonate of lime accumulation in the substratum, where the eastern sections of the Great Plains merge with the treeless areas of the Prairie soils having no such accumulation. The Plains here, although irregularly dissected, have a general regional slope toward the southeast. The drainage divide between Salt Fork Arkansas River and Cimarron River comprises the highest land in the county and consists of a smoothly rolling or undulating broad ridge that enters about midway of the western boundary and extends in a southeasterly direction through the southern part, leaving at the southeastern corner.

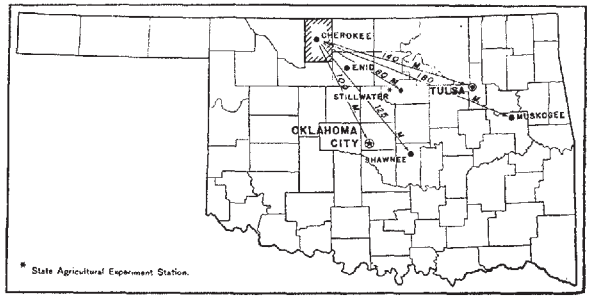

FIGURE 1.—Sketch map showing location of Alfalfa County, Okla.

The surface of the plain has been slightly dissected. The relief is generally rolling and is featured by several shallow broad valleys, chief of which is the valley of Salt Fork Arkansas River that crosses the north-central part of the county from northwest to southeast. The most outstanding topographic feature is a large low flat plain bordering this valley in the eastern part of the county. This plain has a flat surface and is devoid of vegetation. A white incrustation of salts causes it to be known locally as the "Great Salt Plains." It covers about 30 square miles and appears to be a lake bed which is dry much of the time. It is bordered by low-lying uplands or flat terraces of water-laid soil materials. The main channel of the river traverses the northeastern edge of this old lake bed and after leaving the plain enters a narrow valley bordered by steep rough slopes.

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Several smaller valleys, occupied by creeks that flow into Salt Fork Arkansas River within the county and Cimarron River just south of the county, have flat smooth narrow flood plains bordered by some rather wide flat high old terraces. These wider flat smooth valley lands lie adjacent to Medicine Lodge River and Sandy, Mule, Eagle Chief, and Wagon Creeks. The flood plains of the larger streams range from ⅛ to 1 mile in width.

Many small areas of rough and broken land occur where steep slopes are carved by erosion into gullies and valleys, mainly at the heads of drainageways and along small draws extending into the Red Beds. The largest and most numerous of these rough areas comprise the eroded escarpment, in which originate the streams of the local drainage basin of Salt Fork Arkansas River. This escarpment, facing eastward, enters the county 20 miles north of the southwest corner and extends southeastward to a point near Carmen (a distance of about 14 miles), then faces northward to the vicinity of McWillie (a distance of about 6 miles), where it turns northward and eastward and changes to an irregular east-west line of more or less broken slopes. These slopes extend north from the drainage divide just north of Helena and Goltry to the general level of the smooth terraces bordering the Great Salt Plains.

Other outstanding features of relief comprise the smooth areas occupied in part by mounds and dunelike areas of sand, which are more abundant in the northeastern and southwestern parts of the county and in a number of river valley areas in the northern part. On the whole, most of the land is moderately or very slightly sloping, and much of it is nearly flat.

Most of the streams are of intermittent flow. It is reported locally that water flows or remains most of the time in Salt Fork Arkansas River, Medicine Lodge River, and Sandy Creek.

The elevation of the flat plain of Salt Fork Arkansas River is about 1,100 feet above sea level, and that of the divide extending through the southern part of the county ranges from about 1,300 to 1,400 feet.

The native vegetation consists mainly of grasses. The heavier soils support buffalo grass, some species of grama, and some of the bluestems; on the lighter textured sandy soils the coarser bunch grasses, largely bluestems, predominate; and on the very light loose deep sandy soils some very coarse grasses and sand sage, together with other herbaceous plants and shrubs, are abundant. On the creek bottoms elm, cottonwood, and other trees originally grew, but these have been cleared off to a great extent, and in places a few post-oak trees grow on the deep sands. Only on the more deeply eroded soils and rougher lands does the native vegetation remain, as most of the tillable soils have been in cultivation a long time.

Alfalfa County originally was within the Cherokee Strip, a reserved tract of public land about 55 miles wide extending from east to west across the State. The land now occupied by Alfalfa County was formally opened for settlement of white people in 1893. This county was organized from a part of Woods County in 1907.

The population of Alfalfa County, according to the census of 1930, is 15,228. About 9,000 of this number live on farms. The other

people live in small towns, of which Cherokee, the county seat, with a population of 2,236, is the largest. The population of the rural sections is fairly well distributed, but it is less dense in the areas occupied by the loose deep sands and thin salty soils adjacent to the Great Salt Plains. Small towns and shipping points are Carmen, Aline, Jet, Helena, Goltry, Byron, Amorita, Burlington, Driftwood, Ingersoll, and Lambert.

All the farms are within a few miles of a shipping point and have access to good transportation facilities. Several railroad lines cross the county from north to south and from east to west, including important branch lines of the Atchison, Topeka & Santa Fe; the Chicago, Rock Island & Pacific; and the St. Louis-San Francisco Railways. These railroads provide easy access to the important market centers of the United States. United States Highway No. 64 extends east and west through the central part of the county, and this paved thoroughfare connects with important paved highways of the State. Some of the county roads are gravel surfaced, and most of the dirt roads in all sections are graded and maintained in good condition.

The rural communities have adequate school and church facilities. Most farm homes are served by rural mail delivery, and many have telephones.

Abundant water of good quality is obtained in shallow wells on many farms, but in places the water contains sufficient salts to render it distasteful. The shallower and more plentiful supplies of good water are on the stream valley terraces and in some sections on the deep sand areas.

CLIMATE

Alfalfa County lies within the subhumid climatic section, where the average annual rainfall is about 29 inches. Ordinarily, soil moisture is sufficient for the growth of crops, as much of the rainfall occurs during the growing season; but during some years the rainfall is very irregular, and long periods of dry weather with little rainfall sometimes cause severe injury to crops, resulting in low yields. The summer heat and dry weather are sufficiently unfavorable to corn to prevent its successful production, and little corn is now grown by the farmers. Much of the rainfall in summer is of a sudden dashing type and results in considerable loss of soil moisture, through rapid run-off on sloping areas.

Nearly one-half of the total yearly rainfall occurs in the four warmest months—May to August, inclusive—and a considerable proportion occurs during the three spring months, which results in a condition favorable for the production of small grains. Periods of very hot dry weather are frequent during the summer.

The mean annual temperature is 58.6° F. The winters are moderate and fairly dry, with much sunshine. Snowfall is light and, as a rule, does not remain long on the ground. Winds are fairly strong in the spring and generally blow from the south, drifting the lighter sandy soils where unprotected and causing injury to growing crops.

The average frost-free season covers a period of 207 days, from April 4, the average date of the latest killing frost, to October 28,

the average date of the earliest. Frost has been recorded as late as May 15 and as early as September 23.

No Weather Bureau station is in the county, but the records of the United States Weather Bureau station at Alva, Woods County, adjoining Alfalfa County on the west, are believed to be representative of climatic conditions in the county. Table 1 gives the more important climatic data, as compiled from the records of that station.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Alva, Woods County, Okla.*

[Elevation, 1,350 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1933)	Total amount for the wettest year (1915)	Snow, average depth
	°F.	°F.	°F.	*Inches*	*Inches*	*Inches*	*Inches*
December	36.9	81	−7	0.98	0.36	0.14	4.1
January	34.7	81	−14	.80	.09	1.21	3.0
February	38.7	88	−14	1.16	.10	3.46	5.2
Winter	36.8	88	−14	2.94	.55	4.81	12.3
March	48.2	99	−1	1.54	.84	2.36	1.6
April	58.1	99	18	2.77	1.49	7.67	.1
May	66.7	105	25	4.50	1.37	8.16	.0
Spring	57.7	105	−1	8.81	3.70	18.19	1.7
June	76.6	114	41	3.65	.12	7.78	.0
July	81.2	114	51	2.90	1.78	2.42	.0
August	80.7	112	45	3.38	5.44	5.16	.0
Summer	79.5	114	41	9.93	7.34	15.36	.0
September	73.4	105	31	3.04	2.06	3.45	.0
October	60.4	99	10	2.33	1.28	3.62	(1)
November	47.7	86	5	1.70	.54	.32	.8
Fall	60.5	105	5	7.07	3.88	7.39	.8
Year	58.6	114	−14	28.75	15.47	45.75	14.8

[1] Trace.

AGRICULTURAL HISTORY AND STATISTICS

The raising of cattle on the open range was the most important occupation in this county when it was first settled, but farming soon replaced ranching. According to the records of the United States census, corn, wheat, and oats were the principal crops in 1909, when 128,578 acres in corn, 106,337 acres in wheat, and 9,514 acres in oats were reported. Corn was then the most important crop, but during the next 10 years the acreage of corn decreased to 13,359 acres, and during the same period the acreage devoted to wheat was more than doubled, and, in 1919, 252,355 acres were reported in wheat. The largest acreage of wheat reported by the census was 275,073 acres in 1929, and corn, in the same year, was grown on 24,280 acres. The acreage in oats remained about the same from 1909 to 1929, because this crop was used only for feed and the farmers did not attempt to

grow any more than was required for that purpose. In 1929, it amounted to 9,056 acres.

The 1935 Federal census reported 1,848 acres of corn harvested for grain and 3,121 acres for other purposes; 11,023 acres of oats threshed for grain and 2,044 acres cut and fed unthreshed; 217,638 acres of wheat; 1,591 acres of rye; 5,384 acres of barley; 4,968 acres of sorghums for grain; 26,183 acres of hay and forage, of which 10,819 acres were in alfalfa; and 12,618 acres in sorghums for forage.

The wheat yield depends on the season. During normal seasons the yield on most farms ranges from 10 to 30 bushels an acre. The chief varieties include Turkey and Kanred. Corn yields from 5 to 10 bushels an acre on the uplands and from 10 to 35 bushels on the bottom lands. The total acreage of rye is very small. This crop is perhaps better suited to sandy soils than most of the other fall-sown grains.

Alfalfa County is along the northern limits of the cotton-growing area of the Southwest. Cotton was introduced into this county a few years ago, and since that time its acreage has increased considerably. In 1909, only 3 acres were in cotton; in 1929, this crop was grown on 836 acres which produced 247 bales, and in 1934 only 324 acres were in cotton. Most of the cotton is grown in the vicinity of Jet and in the extreme southwestern part of the county. The only cotton gin is at Jet.

Cherokee, the county seat, was at one time considered to be located in the greatest alfalfa-growing center of northwestern Oklahoma. In 1909, alfalfa was grown on 13,444 acres and in 1919 on 17,615 acres. The total acreage had decreased to 6,108 acres in 1929 but by 1934 had increased to 10,819 acres.

Apples, peaches, and grapes are grown chiefly in the southwestern part of the county where the soils are sandy. A commercial orchard covering 120 acres is southwest of McWillie, in which apples are the predominant fruit, although cherries and grapes are grown on a commercial scale.

Watermelons and cantaloups are grown on almost every farm composed of sandy land. On a few farms they are grown on an acreage sufficient to provide a surplus to be sold at the local market. The 1935 census reported 150 acres devoted to watermelons in 1934.

Garden vegetables are generally grown successfully wherever the soil has a sandy texture. In the northeastern part of the county, where sandy soils are prevalent, there are some very excellent vegetable gardens along narrow valleys that are irrigated from spring-fed streams.

The soil map of the county shows that most land sections of 640 acres have three farmsteads. Some have two or four, but none has more than four. The farmstead includes a house, a barn, and a few small buildings for the housing of livestock and storage of feed. The census of 1935 reported 2,164 farms in the county, averaging 230.7 acres each. Of the total number, 1,151 were operated by owners and part owners, 1,005 by tenants, and 8 by managers.

The 1930 census reported the average value of all farm property a farm as $16,549, of which 76.5 percent represents the value of land, 10.5 percent the value of buildings, 7.5 percent the value of imple-

ments, and 5.5 percent the value of domestic animals. The average value of farm land in that year was $64.54 an acre. The 1935 census reported the average value of land and buildings a farm as $9,610 and the average acre value as $41.65.

The expenses on most farms include labor, fuel for operating tractors, and repair of machinery. The expenses for labor reported on 62.5 percent of the farms in 1929 averaged $191.08 a farm; and an expenditure for feed reported on 56.7 percent of the farms averaged $189.41. Very little commercial fertilizer is purchased. Only six farms reported an average expenditure of $102.33 for fertilizers in 1929.

Most of the farms are equipped with improved machinery and implements. Tractors are commonly used for most of the field work on farms where wheat is grown extensively. Many farmers use combines for harvesting wheat, and in some communities the combines are owned by several farmers in partnership. The demand for extra help during harvest is small.

Table 2 gives the acreage of the principal crops grown, as reported by the census from 1909 to 1934, inclusive.

TABLE 2.—*Acreage of principal crops in Alfalfa County, Okla., in stated years*

Crop	1909	1919	1929	1934
	Acres	*Acres*	*Acres*	*Acres*
Wheat	106,337	252,355	275,073	217,638
Corn	128,578	13,359	24,280	1,848
Oats	9,514	10,752	9,056	11,023
Barley	1,467	700	1,083	5,384
Rye	13	1,552	277	1,159
Sorghums for grain	6,142	11,618	7,583	4,968
Dry peas	392	39	306	----------
Potatoes	459	188	244	95
Hay and forage	28,205	34,377	18,360	26,183
Sorghums	128	7,632	9,455	12,618
Tame grasses	13,983	19,327	7,028	[1] 1,561
Wild grasses	8,370	3,506	1,546	----------
Alfalfa	13,444	17,615	6,108	10,819
Clover	10	67	275	16
Broomcorn	692	30	82	----------
Cotton	3	----------	836	324
	Trees	*Trees*	*Trees*	*Trees*
Apples	64,152	19,551	8,888	6,308
Peaches	159,123	11,872	6,488	4,821
	Vines	*Vines*	*Vines*	*Vines*
Grapes	88,238	10,002	8,573	3,899

[1] Includes both tame and wild grasses.

Although much of the farm work is done by machinery, many farmers use considerable numbers of work animals. The census of 1935 reports 6,618 horses and 860 mules on the farms.

Most of the cattle are dairy cattle of the Jersey breed. A small number of beef cattle, mainly Herefords, are kept on a number of farms. The census of 1935 reported a total of 48,889 cattle in this county, of which 12,314 were milk cows which produced 4,469,487 gallons of milk in 1934. Not a large amount of feed above local requirements is grown, and in years when feed is not grown in large enough quantities, some must be purchased from outside. Much of the land in wheat is grazed by beef cattle and sheep during the win-

ter. Most of these animals are shipped in from the ranges of Texas, Oklahoma, and New Mexico, and they are shipped out in the spring to other States for finishing for market on corn. Considerable cream is shipped to outside markets by many farmers who produce a surplus of milk above home requirements. Most farmers raise and fatten a few hogs for meat for home use and local sale. The census reported 8,372 swine on the farms in 1935. The 1935 census reported 169,163 chickens and 4,665 turkeys on January 1 of that year. The same census reported 369,896 chickens raised and 940,780 dozen eggs produced in 1934.

According to the 1935 census, the total land available for crops comprised 367,036 acres, or about 66.1 percent of the total area of the county. The average amount of cropland a farm was 169.6 acres, but on many farms a much larger proportion of the land seems to be in cultivation than is indicated by this figure.

The greater number of farms range from 100 to 500 acres in size, 373 farms include less than 100 acres each, and 115 farms include more than 500 acres, of which 13 exceed 1,000 acres.

The value of all field, orchard, and garden crops produced in 1929 was $4,147,726. Of this, the value of cereals (mainly wheat) amounted to $3,540,531, and of hay and forage, $372,218. Most of the other products sold were small quantities of fruits and vegetables. The value of livestock of all kinds in 1930 was $2,267,706; the butter, cream, and whole milk sold in 1929 amounted to $511,854; the value of poultry raised was $344,793; and chicken products sold amounted to about $293,000.

SOIL-SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field.

The soils are examined systematically in many locations. Test pits are dug, borings are made, and exposures, such as those in road or railroad cuts, are studied. Each excavation exposes a series of distinct soil layers, or horizons, called, collectively, the soil profile. Each horizon of the soil, as well as the parent material beneath the soil, is studied in detail; and the color, structure, porosity, consistence, texture, and content of organic matter, roots, gravel, and stone are noted. The reaction of the soil [1] and its content of lime and salts are determined by simple tests. Drainage, both internal and external, and other external features, such as relief, or lay of the land, are taken into consideration, and the interrelation of soils and vegetation is studied.

The soils are classified according to their characteristics, both internal and external, special emphasis being given to those features influencing the adaptation of the land for the growing of crop plants, grasses, and trees. On the basis of these characteristics soils are grouped into mapping units. The three principal ones are (1) series, (2) type, and (3) phase. Areas of land, such as coastal beach

[1] The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality, higher values indicate alkalinity, and lower values indicate acidity.

or bare rocky mountain sides, that have no true soil are called (4) miscellaneous land types.

The most important group is the series, which includes soils having the same genetic horizons, similar in their important characteristics and arrangement in the soil profile, and developed from a particular type of parent material. Thus, the series includes soils having essentially the same color, structure, and other important internal characteristics and the same natural drainage conditions and range in relief. The texture of the upper part of the soil, including that commonly plowed, may vary within a series. The soil series are given names of places or geographic features near which they were first found. Thus, Reinach, Pratt, Yahola, and Enterprise are names of important soil series in this county.

Within a soil series are one or more soil types, defined according to the texture of the upper part of the soil. Thus, the class name of the soil texture, such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam, and clay, is added to the series name to give the complete name of the soil type. For example, Yahola silty clay loam and Yahola fine sandy loam are soil types within the Yahola series. Except for the texture of the surface soil, these soil types have approximately the same internal and external characteristics. The soil type is the principal unit of mapping, and because of its specific character it is usually the soil unit to which agronomic data are definitely related.

A phase of a soil type is a subgroup of soils within the type, which differ from the type in some minor soil characteristic that may, nevertheless, have important practical significance. Differences in relief, stoniness, and the degree of accelerated erosion are frequently shown as phases. For example, within the normal range of relief for a soil type, there may be areas that are adapted to the use of machinery and the growth of cultivated crops and others that are not. Even though there may be no important difference in the soil itself or in its capability for the growth of native vegetation throughout the range in relief, there may be important differences in respect to the growth of cultivated crops. In such instances the more sloping parts of the soil type may be segregated on the map as a sloping or hilly phase. Similarly, soils having differences in stoniness may be mapped as phases, even though these differences are not reflected in the character of the soil or in the growth of native plants.

The soil surveyor makes a map of the county or area, showing the location of each of the soil types, phases, and miscellaneous land types, in relation to roads, houses, streams, lakes, section and township lines, and other local cultural and natural features of the landscape.

SOILS AND CROPS

As agriculture is the chief, and almost only, source of income to the people of Alfalfa County, the principal resource is the soil. The soils of the county have been in use a comparatively long time, and the fairly high average degree of prosperity and well-being attained by the inhabitants reflects, to considerable extent, the capacity of most of the soils to produce moderately large yields of the important crops.

The intensive use of the better soils attests their agricultural value, which during the last four decades has been sufficiently good to enable the development of a permanent and stable type of agriculture.

Alfalfa County lies at the eastern border of the subhumid section of the United States, where the rainfall is not high. During some seasons, the rainfall is irregular and at times is so deficient as to be inadequate for the best production of crops; therefore, the best yields of crops are obtained on soils that have a good store of plant nutrients and characteristics that enable crops to withstand droughts.

The value of the various soils for crops is to a large extent dependent on their physical and other characteristics, and on this basis they may be placed in seven groups as follows: (1) Moderately heavy smooth upland soils, including Pond Creek silt loam, Grant very fine sandy loam, Nash very fine sandy loam, Kay silt loam, Reinach silt loam, Reinach very fine sandy loam, Reinach silty clay loam, Amorita clay loam, and Foard clay loam; (2) loamy light sandy soils, including Pratt fine sandy loam, Carwile fine sandy loam, Carmen fine sandy loam, Pratt sandy loam, Reinach fine sandy loam, Enterprise loamy fine sand, Pratt loamy fine sand, and Reinach loamy very fine sand; (3) alluvial soils, including Yahola silty clay loam, Yahola very fine sandy loam, and Yahola fine sandy loam; (4) very light loose deep sands, including Enterprise fine sand, dune phase, and Pratt loamy coarse sand; (5) thin soils of slight development, of which Vernon very fine sandy loam is the only representative; (6) saline soils, including Drummond very fine sandy loam and Kay very fine sandy loam, saline phase; and (7) nonarable land types, including rough broken land (Vernon soil material) and riverwash.

Wheat is the dominant small-grain crop. It is the most important crop of this section and is grown on most farms where the soils are suitable. The smooth soils, ranging from fine sandy loam to silty clay loam in texture, are used most extensively for this crop. Wheat is grown to a considerable extent also on the loamy light sandy soils and the alluvial soils. In fact, this crop is grown on almost every kind of soil that can be cultivated, but the best yields and the largest acreage are on soils of the first group—the moderately heavy smooth upland soils.

The feed crops are grown largely on soils of the first, second, and third groups. Alfalfa is grown on the smoother soils of the stream terraces, principally those of the first and third groups. Corn has not held its original importance as a crop, but it still ranks next to wheat in acreage. Owing to climatic conditions, chiefly lack of rainfall in early summer, yields of corn are often very low, and sorghums, which withstand drought better than other crops, are a more certain feed crop. Corn and the feed crops, mainly sorghums, are grown largely on the alluvial soils and the loamy light sandy soils, because moisture conditions are better.

In the following pages, the soils of Alfalfa County are described in detail, and their agricultural relationships are discussed; their location and distribution are shown on the accompanying soil map; and their acreage and proportionate extent are given in table 3.

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TABLE 3.—*Acreage and proportionate extent of the soils mapped in Alfalfa County, Okla.*

Type of soil	Acres	Per-cent	Type of soil	Acres	Per-cent
Pond Creek silt loam	48,896	8.8	Reinach loamy very fine sand	4,352	0.8
Grant very fine sandy loam	45,376	8.2	Yahola silty clay loam	11,648	2.1
Nash very fine sandy loam	32,000	5.8	Yahola very fine sandy loam	12,544	2.3
Kay silt loam	25,344	4.6	Yahola fine sandy loam	8,896	1.6
Reinach silt loam	34,432	6.2	Enterprise fine sand, dune phase	52,736	9.5
Reinach very fine sandy loam	30,784	5.5	Pratt loamy coarse sand	3,776	.7
Reinach silty clay loam	2,112	.4	Vernon very fine sandy loam	48,640	8.7
Amorita clay loam	6,016	1.1	Drummond very fine sandy loam	19,200	3.5
Foard clay loam	9,152	1.6	Kay very fine sandy loam, saline phase	4,928	.9
Pratt fine sandy loam	12,928	2.3	Rough broken land (Vernon soil material)	19,328	3.5
Carwile fine sandy loam	6,656	1.2	Riverwash	25,472	4.6
Carmen fine sandy loam	3,328	.6			
Pratt sandy loam	9,472	1.7	Total	554,880	
Reinach fine sandy loam	4,224	.8			
Enterprise loamy fine sand	27,904	5.0			
Pratt loamy fine sand	44,736	8.0			

MODERATELY HEAVY SMOOTH UPLAND SOILS

The moderately heavy smooth upland soils include those soils that range from undulating to nearly flat and in texture are largely silt loams and very fine sandy loams, together with some small areas of clay loams. These soils have fairly heavy subsoils, and they collect and retain a considerable proportion of the rainfall, thereby providing a reserve store of water for plant growth in dry seasons. These soils are moderately productive and are used largely for growing wheat.

Pond Creek silt loam.—The surface soil of Pond Creek silt loam consists of an 8-inch layer of brown silt loam which contains an appreciable quantity of silt, giving the material a smooth velvety feel. This material is friable and easily cultivated. It is somewhat laminated when dry but has no definite structure. It grades into dark-brown heavy very fine sandy loam or silt loam, which, on drying, is laminated and platy and consists of lightly bound friable fine particles. At a depth of about 15 inches, this material, in turn, grades into dark-brown crumbly silty clay loam, and this passes, at a depth ranging from 24 to 30 inches, into heavy but crumbly dark-brown or brown clay which, on drying in exposed banks, separates naturally into cubical blocks from 1 to 1½ inches in diameter. Below a depth of about 4 feet the material is sandy and more or less calcareous. When moist Pond Creek silt loam is very dark, but on drying in cultivated fields it is grayish brown on the immediate surface.

This soil occurs in a number of large nearly flat areas in the southern and western parts of the county. Large areas are in the vicinity of Goltry in the southeastern part, and a very large area is several miles west and southwest of Lambert.

This soil is developed over Red Beds calcareous materials, shales, and sandstones of fine texture. These beds have weathered deeply, producing a well-developed soil which is not calcareous above a depth of 3 feet but is about neutral in reaction. Because of the smooth nearly flat relief, water drains very slowly from the land, and erosion is slight.

This is a very important agricultural soil, and almost all of it is in cultivation. The land is used largely for the production of wheat,

oats, and sorghums, and, when moisture conditions are favorable, excellent yields are obtained. This is probably the most valuable upland soil in the county.

Crop yields vary in accordance with moisture conditions, and, as this is a section in which the rainfall during some years is low, the average yields are not true measures of the inherent productive capacity of this soil. In seasons of adequate moisture, yields of wheat are as high as 30, or even 40, bushels an acre, but the average yield is probably about 18 bushels. Oats yield about 25 or 30 bushels, but double this yield may be obtained during some seasons. Grain sorghums are grown to some extent, and a small acreage is devoted to corn, but these crops produce only moderate yields—probably averaging about 20 bushels an acre over a period of years. Alfalfa does well and yields about 2 tons of hay an acre in a season when three or four cuttings are made. Barley yields from 20 to 30 bushels in good seasons. Most of this land is used for the growing of wheat.

Grant very fine sandy loam.—The 6- to 10-inch surface soil of Grant very fine sandy loam consists of brown very fine sandy loam which is friable and structureless. It grades into brown or reddish-brown heavy very fine sandy loam or crumbly friable clay loam, which reaches to a depth of 18 or 20 inches. This is a very permeable layer. It is underlain by slightly heavier reddish-brown crumbly clay or clay loam. The material in none of these layers is calcareous, although the surface soil and subsoil are about neutral in reaction. In some of the smoothly undulating areas this soil appears to be the developed product of deeply weathered calcareous shales and sandstones of the Red Beds, but in places a few fine quartz gravel occur in the subsoil, and in other places the soil is underlain by beds of fine gravel. In a few places the parent material is somewhat calcareous below a depth of 3 feet and possibly indicates a slight accumulation of calcium carbonate or the carbonate of the geological formation beneath.

The relief is undulating or slightly rolling, and the run-off of rain water is greater than on the flat Pond Creek silt loam, but, as a rule, erosion is not severe.

This soil, which is easily cultivated, is considered one of the best agricultural soils of the county. It rates very close to Pond Creek silt loam in productiveness. Practically all of the land is in cultivation, mainly to wheat. The soil probably is about as productive for wheat as is Pond Creek silt loam, but it is slightly less suited to alfalfa on account of the less favorable moisture-collecting capacity of the more sloping soil. According to local reports, wheat yields range from 15 to 18 bushels an acre—much higher in good seasons; corn from 15 to 20 bushels, and grain sorghums approximately the same as corn. Alfalfa yields from 1½ to 2 tons, or more in a season when three cuttings are made, and it yields 3 or 4 bushels of seed at the last cutting. This soil originally supported a sod of buffalo and grama grasses, with some bunch grasses, but little of it remains uncultivated.

Grant very fine sandy loam occupies many large and small areas, more or less associated with Pond Creek silt loam. Some of them are a few miles southeast of Cherokee, and some are in the northwestern part of the county north of Burlington. The soil is devel-

oped largely from the same character of parent materials as is Pond Creek silt loam, but in places it appears to be developed partly from thin water-laid deposits of the Tertiary or Quaternary periods.

Nash very fine sandy loam.—Nash very fine sandy loam is a red soil developed from Red Beds shales and fine-grained sandstones, that are more or less calcareous. This soil represents a stage of development midway between the Vernon soils—the very immature shallow soils of the Red Beds—and the Grant soils which are the deeper normally developed soils on smooth relief.

The 8-inch surface soil of Nash very fine sandy loam is red or reddish-brown very fine sandy loam. It grades into slightly heavier and more red very fine sandy loam. This material grades, at a depth ranging from 2 to 3 feet, into the partly weathered parent shales or beds of soft very fine grained sandstone of the Red Beds. In places the material is calcareous to a position within 12 inches of the surface, and in other places it is not calcareous above the parent material.

The relief of Nash very fine sandy loam is undulating or gently rolling. Where unprotected, the soil is subject to severe sheet erosion, and in places where this type of erosion is allowed to continue, much of the developed soil material is removed, and the resulting shallow soil is correlated as Vernon very fine sandy loam.

The Nash soil is moderately productive, although rapid run-off of rain water and erosion lower yields of crops to some extent. The soil seems to be low in organic matter, but, by terracing and growing and plowing under such crops as sweetclover, its productivity can be improved. The land is used largely for the growing of wheat, but average yields are probably not much more than one-half as high as those produced on Pond Creek silt loam. This soil is not highly suited to alfalfa, but on the exceptionally smooth areas yields are fair. It will produce about 15 bushels of grain sorghums and 1 to 2 tons of forage an acre, as it is fairly well suited to sorghums and Sudan grass. This is not a very good soil for corn.

Nash very fine sandy loam occurs in many small areas, chiefly in the southern part of the county.

Kay silt loam.—The 10-inch surface soil of Kay silt loam is very dark brown silt loam. The material is very friable and contains a fairly large quantity of very fine sand, in places so high a content that the texture possibly is very fine sandy loam. Such areas would have been mapped separately had they been larger. This material is not calcareous but is neutral or basic in reaction. It grades into slightly heavier darker material which ranges from heavy very fine sandy loam or silt loam to crumbly friable and somewhat granular silty clay loam in places. This material also is not calcareous. At a depth ranging from 18 to 24 inches, it grades into brown heavy but crumbly clay that is not calcareous, and the clay passes, at a depth ranging from 3 to 4 feet, into reddish-brown calcareous clay that with increase in depth, becomes gradually lighter in texture, and at a depth between 4 and 5 feet, in places, is underlain by calcareous very fine sandy loam. This soil has very much the same features and characteristics of the profile as has Pond Creek silt loam, but it differs from that soil in that the lower layers, or substrata, are more friable and sandy and rest on ancient alluvium instead of Red Beds. Areas of this soil

merge, in many places, with Reinach silt loam, and in places these soils are similar, but Kay silt loam is darker in both the surface soil and subsoil, and the subsoil is considerably heavier.

Kay silt loam is an extensive soil. It occurs in large areas in the northern part of the county in the vicinity of Cherokee, east of Driftwood, and north of Burlington. It occupies flat smooth terraces of old alluvium, which lie high above overflow. It is associated with Reinach silt loam and Reinach very fine sandy loam on the broad terraces that lie several feet above the flood plains of Salt Fork Arkansas River, Medicine Lodge River, Cottonwood Creek, and other streams. There is sufficient slope in most places to allow surface water to pass away freely, and drainage is not a problem.

This is considered one of the most productive soils, if not the best soil, in the county, as it produces good yields of all crops when moisture conditions are favorable. The soil is well supplied with available plant nutrients, and the friable consistence allows ready penetration of moisture and plant roots. All the land is in cultivation and is highly prized, as it is readily cultivated and has such smooth nearly flat relief that most of the rain water is absorbed readily, and stored for the use of plants. The principal crops are wheat and alfalfa; and some barley, oats, Sudan grass, sorgo, and grain sorghums are grown. Not much corn is grown because of summer droughts that frequently occur at the critical stage of growth. According to local information, the acre yields of the different crops are about as follows: Alfalfa, 2½ tons; alfalfa seed, from 2 to 6 bushels; wheat, from 15 to 25 bushels in seasons of moderate rainfall but not so high when considerable moisture is in the soil, as such a condition causes too rank a growth of stalk; oats, from 30 to 50 bushels; and sorghums, from 15 to 20 bushels of grain and 1 to 3 tons of forage.

Reinach silt loam.—The 12-inch surface soil of Reinach silt loam consists of chocolate-brown silt loam which, although probably basic or at least neutral, does not respond to a field test for calcium carbonate. This layer contains considerable very fine sand, and possibly some spots are sufficiently sandy for the soil to be classed as Reinach very fine sandy loam. On drying in well-tilled fields, the material has a slight red hue in places. It grades into slightly heavier material—chocolate-brown or slightly reddish brown silty clay loam—which, at a depth of about 2 or 2½ feet, changes to crumbly rather light textured red or reddish-brown clay. Below a depth of about 4 feet, the clay becomes more friable and sandy and is underlain, through a gradational change, by red calcareous very fine sandy loam. In most places the material is calcareous at a depth of about 3 feet below the surface. Both surface soil and subsoil are readily permeable and afford good root penetration. The subsoil is slightly granular when dry, but it does not show much development of true granules.

The relief is almost flat, but in most places water passes from the soil readily or sinks into it, and drainage is good. In general the water table lies at a depth ranging from 10 to 20 feet. The parent material is old alluvium originally washed from soils of the Red Beds.

This soil occupies a number of good-sized areas in the valley on smooth flat terraces that lie several feet above the flood plain of Salt Fork Arkansas River. Cherokee is located on a large area of this soil.

Reinach silt loam is an excellent soil, and practically all of it is in cultivation. It is used largely for the production of wheat which yields as high as 30 bushels an acre in very good seasons, but the average yield is probably between 15 and 20 bushels. It is reported that in dry seasons wheat yields are somewhat higher than on the more rolling upland soils, but in seasons of considerable rain the plants make a heavy rank growth of straw without a corresponding increase in grain. This is a very good soil for alfalfa, and much is grown. Three or four cuttings are obtained in a season, and, if moisture conditions are favorable, one cutting will yield from 1 to 1½ tons an acre, but the average total yield in good seasons is between 2½ and 3 tons. Many farmers allow the crop to mature seed, and the yield ranges from 2 to 6 bushels an acre, although under unusually good conditions as much as 10 bushels has been produced. Oats yield from 30 to 50 bushels in good seasons, but in some very dry seasons yields are very low. Barley is grown by some farmers for use as livestock feed in preference to corn, as the latter crop is less certain to yield well because it is often injuriously affected by summer drought. Some grain sorghums are grown and produce from 15 to 20 bushels of grain. These crops and sorgo yield from 1 to 3 tons of forage.

Reinach very fine sandy loam.—The surface soil of Reinach very fine sandy loam is chocolate-brown or reddish-brown very fine sandy loam about 10 inches thick. It is friable and normally is not calcareous although it is neutral or basic in reaction. In many places the surface soil passes with little change in texture into the subsoil consisting of reddish-brown or brownish-red very fine sandy loam. The material in the subsoil varies considerably from place to place and in some places is loamy very fine sand. In places it is calcareous but, as a rule, it is not calcareous above a depth of about 2 feet. In places, such as in the vicinity of Driftwood, the subsoil below a depth of 2½ or 3 feet is red clay loam that is crumbly, friable, and calcareous.

Reinach very fine sandy loam occupies many small bodies in various sections of the county on second bottoms, or stream terraces, where it is associated with Reinach silt loam and other soils of the terraces. The largest bodies are along the south side of Salt Fork Arkansas River, bordering Mule Creek, and along Medicine Lodge River in the vicinity of Driftwood. Narrow strips of this soil occur in the southeastern part of the county near Jet on narrow benches of small valleys. The soil borders a number of small streams as very high first bottoms which occasionally, but very rarely, are overflowed for short periods. It also borders shallow winding drainageways extending from the higher rolling areas across the flat high terraces of old alluvium. Occasional heavy rains cause the channels to overflow and spread water out onto the smooth terrace lands for some distance, and this has caused a deposition of red silt and very fine sand, which has washed from the Red Beds, as high embankments along the drainageways.

Reinach very fine sandy loam occupies smooth flat areas of high stream terraces that lie above ordinary overflows. Some areas have slightly undulating relief, and both surface and internal drainage are very good.

This soil is considered a valuable farming soil, and most of it is in cultivation. The same crops are grown as on Reinach silt loam, that is, wheat, oats, barley, alfalfa, and some sorghums. The very fine sandy loam varies considerably in degree of productiveness, largely in proportion to the character of the subsoil. In places where the subsoil is very sandy to a depth of several feet, the land is less productive and more droughty than where the subsoil includes a heavy layer, such as a clay loam, like that beneath much of the soil in the vicinity of Driftwood. Although this soil is very productive on the whole, average yields are probably slightly lower than those obtained on Reinach silt loam. According to local reports, wheat yields from 12 to 15 bushels an acre, alfalfa about 2 tons, and grain sorghums about 15 bushels. The grain sorghums and sorgo yield from 1 to 3 tons of dry forage an acre.

Reinach silty clay loam.—The surface soil of Reinach silty clay loam is reddish-brown silty clay loam about 10 inches thick, which is not calcareous but probably is basic or nearly neutral in reaction. This material grades into red or reddish-brown heavy crumbly clay that contains a large quantity of silt, possibly sufficient to make the texture silty clay. The material in this layer is not calcareous, but, at a depth of about 2 or 2½ feet, it changes to dark reddish-brown calcareous fine sandy loam and with increase in depth is very fine sandy loam. In places adjacent to slopes of the higher lying upland soils, some overwash of dark soil material has resulted in a dark-brown surface soil.

Reinach silty clay loam occurs on high flat benches in the valley of Eagle Chief Creek, bordering the first bottoms and lying from 10 to 15 feet higher than the land subject to overflow. Surface drainage is slow, but this is an advantage as it allows rain water to be retained and stored in the surface soil and subsoil. This soil occupies a number of narrow small areas in the southwestern corner of the county in the vicinity of Aline.

All the land is in cultivation and is considered a valuable soil for the production of wheat, oats, barley, and alfalfa. The principal crops are wheat and alfalfa, and these do well. Wheat yields from 15 to 18 bushels an acre and alfalfa from 2½ to 3 tons. Grain sorghums yield an average of 18 bushels of grain an acre.

Amorita clay loam.—The surface soil of Amorita clay loam consists of brown or dark-brown heavy clay loam which in places is almost black and in some places contains an appreciable quantity of fine sand. It ranges from 8 to 14 inches in thickness, is fairly heavy, and is not calcareous. It passes gradually into heavy reddish-brown tough clay which in places is calcareous and contains white particles and soft lumps of calcium carbonate and perhaps some gypsum. This heavy clay layer is several feet thick, and local reports state that it rests on beds of sand and gravel at a depth ranging from 10 to 15 feet.

The relief of this soil is flat or slightly depressed, and drainage is slow on the slightly lower areas which follow swales or are of lake-bed form, although, as a rule, the surface of the land is only very slightly lower than that of the surrounding soils.

Amorita clay loam is of small extent. The largest areas are in the northeastern part of the county in the vicinities of Amorita and Byron, and small areas are north of Burlington in depressed situa-

tions. This soil in places occupies smooth high terraces in close association with Kay silt loam. Drainage is very slow in depressed areas, but most of the soil is successfully cultivated regardless of the occasionally wet condition. It is, however, very difficult to cultivate, as it is sticky when wet and packs tightly on drying.

This is considered very good land for the production of alfalfa and wheat, and it is used largely for these crops. Farmers report that yields of alfalfa are approximately 2 or 2½ tons an acre from three or four cuttings. Wheat produces from 15 to 25 bushels under normal conditions, although the average yield is probably not more than 15 bushels. Some Sudan grass is grown and provides good pasture, and when cut for hay it yields from 1 to 3 tons an acre. Good water is obtained almost everywhere by drilling down into the bed of gravel and sand, which lies from 10 to 30 feet below the surface.

Foard clay loam.—The 4- to 10-inch surface soil of Foard clay loam is brown or dark-brown clay loam which when moist is very dark or almost black. It is a structureless mass of tightly bound material when dry and is somewhat sticky when wet, and it is not calcareous. This material passes, through a very thin transitional layer, into dense tough brown clay of claypan character, but there is no gray layer on top of the clay. This clay subsoil, in turn, passes, at a depth of about 20 inches, into grayish-brown calcareous clay that contains some fine concretions of calcium carbonate. Below a depth of about 32 inches, the subsoil is yellowish-brown crumbly calcareous clay containing many small hard concretions of calcium carbonate, and this probably represents the zone of calcium carbonate accumulation. It is about 20 inches thick and below a depth of about 50 inches merges with reddish-yellow calcareous friable clay which passes, at a depth ranging from 10 to 12 feet, into soft unweathered red sandy clay material constituting the Red Beds.

The relief is flat or slightly undulating, and for the most part surface drainage is sufficiently free that water does not remain on the surface after rains. On the sloping areas the unprotected soil is subject to some erosion, because penetration of water is very slow and much run-off of rain water takes place. In this county this soil is of slight extent, but it is more extensive in counties farther west.

All the land is in cultivation, and the chief crop is wheat. The land is of moderate productiveness, but, in most years, yields of crops are not so good as those obtained on the deep lighter textured soils. Wheat yields average between 10 and 12 bushels an acre. The soil is difficult to cultivate, but when worked at the proper moisture content, a shallow friable seedbed is maintained. Sorghums and Sudan grass produce good yields of hay. The soil is not well suited to the production of corn or alfalfa.

LOAMY LIGHT SANDY SOILS

The group of loamy light sandy soils includes a number of soils having light loose sandy surface soils that are more or less loamy and texturally comprise fine sandy loams and loamy fine sands, with friable subsoils of fine sandy clay, fine sandy loam, or loamy fine sand. These soils are rather extensive in the southwestern and north-

eastern parts of the county, and some large areas are just north of Salt Fork Arkansas River in the north-central part. Although these soils are rather loose and have free underdrainage, they collect most of the rain water and little run-off occurs. The water table is sufficiently high that shallow wells furnishing good water are commonly obtained on most of the sandy-land farms.

These soils give up moisture to plants readily, and on most of them crops do well in rather dry seasons. The surface soils are so loose that the material blows and drifts in heavy winds. The soils are not so well suited to wheat and small grains as are the heavier members of the group of moderately heavy soils, but the prevalent moisture conditions favor the growth of such crops as corn, sorgo, grain sorghums, and other feed crops. These soils are moderately productive and are rather extensively used. Considerable wheat is grown, fruits and berries do well, and vegetables and truck crops can be grown easily.

Pratt fine sandy loam.—The surface soil of Pratt fine sandy loam consists of grayish-brown fine sandy loam containing some coarse sand and medium sand. The material in this layer is not calcareous, although it is not acid. At a depth of about 12 inches, it grades into yellowish-brown sandy loam or fine sandy loam, which is very friable and is not calcareous. With increasing depth the subsoil becomes heavier, and in many places, below a depth of 24 inches, the material is yellowish-brown or reddish-brown sandy clay. The material in this layer is extremely variable both in texture and in color, and in places the lower part of the subsoil contains very little clay and is largely loamy sand.

This soil occupies a number of small areas. The larger ones are in the southern part of the county in the vicinity of Helena and a few miles northwest of Carmen. A number of small included bodies several miles southwest of Burlington have a very light sandy subsoil including some loamy fine sand. No calcium carbonate is present in either the surface soil or the subsoil.

Pratt fine sandy loam is characterized by smoothly undulating or nearly flat relief with, in places, slight swells and low smooth ridges where the soil is more sandy than in the intervening depressions. The soil collects and retains a considerable proportion of the rain water, and crops withstand periods of dry weather fairly well.

A considerable proportion of the land is in cultivation, and the principal crops are wheat and sorghums. Yields of wheat average about 10 bushels an acre, of grain sorghums from 15 to 20 bushels, and of Sudan grass from 1 to 2 tons of hay. Fruits and vegetables do well, but only small plantings are made around the farm homes.

Carwile fine sandy loam.—The 10-inch surface soil of Carwile fine sandy loam is grayish-brown or dark-gray fine sandy loam or loamy fine sand. It is underlain by yellow, yellowish-brown, or mottled gray and yellow sandy clay which in places is very hard and tough. Below a depth ranging from 18 to 24 inches, this material merges with gray or yellow, or mottled yellow and gray, lighter textured material—sandy clay or sandy loam. In many places the subsoil contains concretions of calcium carbonate at a depth ranging from 2 to 3 feet, also some black fine pellets of iron or manganese concre-

tions. Probably the calcareous concretions represent the zone of carbonate accumulation, although the fine earth material is not calcareous. The surface soil is uniform in most places. The subsoil varies considerably in texture, color, and thickness, but, in general, it is rather tough and contains some sand. In most places coarse sandy material lies at a depth ranging from 2 to 3 feet.

This soil occurs in numerous small areas in the southwestern part of the county in the general section within a few miles east and west of Aline. It has developed in smooth flat depressions between the higher lying areas of the Pratt and Enterprise soils. In rainy seasons the water table lies at a slight depth, and much of the moisture comes as seepage water from the adjacent higher lying sandy soils.

This soil is cultivated to some extent. More corn is grown on it than on some of the other soils because of the more moist subsoil conditions, but only moderate yields are produced. Yields of other crops (chiefly wheat, sorghums, and barley) are slightly higher than those obtained on the adjoining fields of Pratt loamy fine sand. Wheat yields an average of about 10 bushels an acre, oats 20 bushels, and sorghum hay and forage between 1 and 2 tons. Barley yields are somewhat higher than those of wheat.

Carmen fine sandy loam.—The surface soil of Carmen fine sandy loam consists of grayish-brown fine sandy loam about 10 inches thick. It grades into brownish-yellow or yellowish-brown calcareous clay loam or fine sandy loam, containing numerous large hard white concretions of calcium carbonate. This material, in turn, grades at a depth of about 2 or 2½ feet into yellowish-brown clay loam or yellow very fine sand or loamy very fine sand, which, though calcareous, contains few or no concretions. In places small mounds of somewhat white material project above the general level of the ground. These mounds are a few feet in diameter and, to a depth of about 15 inches, consist of gray chalky calcareous clay or marl, containing hard white concretions of calcium carbonate. The material beneath is yellow and gray mottled chalky calcareous clay which, at a depth of 2 feet, is underlain by gray calcareous sand. In places the subsoil is reddish brown, but in other places no red material occurs above a depth of 5 feet, and below that depth it is reddish-brown soft calcareous clay which resembles Red Beds material.

Carmen fine sandy loam is of small extent, and most of it occurs in a body including several square miles southeast of the town of Carmen. The relief is undulating, and drainage is good but not sufficiently rapid to cause severe erosion. All the land is in cultivation and is very productive. It is used largely for wheat, but some sorghums and other feed crops are grown. Crops yield about the same as those on Pratt fine sandy loam.

This is an unusual soil, and its origin and the source of its parent material are obscure. It occupies a strip of low upland at the edge of the valley of Eagle Chief Creek, and the higher lying soils beyond are mainly sandy soils of the Pratt series, which extend a mile or more sloping gradually to the crest of the Red Beds escarpment facing in the opposite direction. It seems probable that the downslope seepage at the base of the shallow Tertiary sands beneath the Pratt soils has removed calcium carbonate from the underlying Red Beds, and as the seepage reached the surface near the valley of Eagle

Chief Creek, evaporation left the calcium carbonate in the upper soil layers. The darker color of the soil probably is due to the weathering of the chalky material and its gradual development into dark soil. Some of the concretions occur in the loose sands of the Pratt soils immediately south of this area of Carmen fine sandy loam.

Pratt sandy loam.—The 10-inch surface soil of Pratt sandy loam consists of brown sandy loam. A rather large proportion of the fine earth is coarse sand, and the rest is fine sand and very fine sand. The surface soil does not have a very large content of organic matter and is only slightly coherent. It grades into red coarse sandy loam or loamy coarse sand, which contains a large quantity of coarse sand and very fine gravel. The soil material is slightly coherent. Below a depth of about 36 inches, the subsoil consists largely of reddish-yellow or yellow fine gravel and coarse sand. None of the material is calcareous. Texturally this soil is an oddity, in that it appears to be composed mainly of coarse sand, fine gravel, fine sand, and very fine sand, with little medium sand. The coarse material increases gradually with depth. Although it has a large content of sand, especially coarse sand, the soil is fairly productive.

This soil occupies a high undulating terrace position in the eastern part of the county in the higher parts of the Salt Plains basin. It lies 20 or more feet above the lower lake terraces which border and lie several feet above the old lake bed. The elevation increases gradually with increasing undulation and slope away from the lake bed. The soil has excellent surface drainage and underdrainage. Although neither the surface soil nor the subsoil contains any calcium carbonate, the material is not highly acid in reaction.

Practically all of this land is in cultivation. It produces well and is somewhat better for the growing of wheat than is to be expected of soils of this texture. The principal crops are wheat, oats, and sorghums. In favorable seasons when the rainfall is adequate, wheat yields from 10 to 15 bushels an acre and oats about 20 bushels.

Most of this soil occurs in a U-shaped more or less continuous body around the southern part of the Salt Plains basin, much of it in the vicinity of Jet.

Reinach fine sandy loam.—The brown fine sandy loam surface soil of Reinach fine sandy loam is about 10 inches thick. It grades into reddish-brown fine sandy loam or loamy fine sand, which, at a depth of 2 or 2½ feet, passes into red loamy fine sand.

This soil occurs in narrow belts in the valley of Eagle Chief Creek in the southwestern part of the county. It occupies flat terraces that border and lie several feet above the flood plain of that stream. In places, small spots mapped as this soil have a layer of very tight heavy dark-colored clay at a depth ranging from 1 to 2 feet beneath the surface.

Practically all the land is in cultivation. The chief crops are wheat and alfalfa, and small acreages are devoted to sorghums and corn. The soil is fairly productive, and yields are about the same as those produced on Reinach very fine sandy loam—possibly slightly lower.

Enterprise loamy fine sand.—The 15-inch surface soil of Enterprise loamy fine sand is brown fine sandy loam or loamy fine sand, which, when dry, is grayish brown at the immediate surface. In places in the fields the soil has a red hue. The material in this layer

gradually passes into reddish-brown sandy loam or loamy fine sand, which, in places, at a depth of about 2 or 2½ feet, grades into reddish-brown sandy clay or coarse sandy loam. Much of this soil, however, has no heavy subsoil layer. The subsoil is not uniform in texture or in the thickness of its various layers, indicating that the water-laid materials have been reworked greatly by the action of winds. No calcareous material was noted in the surface soil, subsoil, or parent material, except in some low areas near Salt Fork Arkansas River where probably very fine calcareous soil had been blown up from the river bed.

The relief ranges from undulating to slightly billowy and mound-like, indicating some wind blowing of the sandy parent materials. The soil occurs in good-sized areas in the vicinities of Aline and Carmen and in the northern part of the river valley, and fairly large bodies are in the northern part of the county near and north of Amorita.[2]

This soil, though very friable and loose, is fairly productive even for small grains. A large proportion of the land is in cultivation, and much of it is used for the growing of wheat which produces very good yields considering the very light texture of the soil. Where bare of vegetation, the dry soil blows somewhat in heavy winds, but this is not a serious problem. Wheat yields probably are slightly lower than on Pratt fine sandy loam, but little difference in productiveness between the two soils is observed in some localities. Probably an average yield of 8 bushels an acre is made over a period of several years on the Enterprise soil. Oats, corn, and grain sorghums yield only moderately. On some fields or in small areas or depressions, alfalfa is grown with fair success. The soil is well suited to apples, plums, cherries, and vegetables, that are grown in the small orchards and gardens around the farm homes.

Pratt loamy fine sand.—The surface soil of Pratt loamy fine sand consists of grayish-brown loamy fine sand about 8 inches thick. This material grades into yellowish-brown or brownish-yellow fine sand or slightly loamy fine sand, which extends to a depth of several feet. Both surface soil and subsoil are slightly coherent and contain only a small quantity of clay and silt.

The relief is undulating, billowy, and slightly dunelike, with irregular low ridges and mounds, which appear to have been blown up by wind. The slight depressions are somewhat darker in the surface layer and more moist beneath, indicating a high water table in places. Where unprotected and when dry, this soil drifts rapidly in heavy winds.

This soil is extensive and occurs in many parts of the county. Large areas are in the northeastern part a few miles east of Byron, in the southwestern part several miles southwest of Carmen, and a few miles east of Aline.[3]

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[2] Areas of Enterprise loamy fine sand along the Grant-Alfalfa County line in places join areas mapped in Grant County as Derby fine sandy loam, reddish-brown phase. Present correlations and revised textural standards indicate the correlation of this soil in Alfalfa County as more appropriate for the county and other areas of the West where soils of pedocalic and pedalferic characters merge.

[3] Along the Alfalfa-Grant County line Pratt loamy fine sand adjoins areas mapped in Grant County as Derby loamy sand. In the light of more recent information this soil is more appropriately correlated in the Pratt series.

In the southwestern part of the county just east of Aline, several bodies of this soil seem to be typical in all respects, except that they have an abundance of large hard concretions of calcium carbonate. Here the soil on a low swell or ridge consists of grayish-brown loamy fine sand to a depth of 10 inches and grades into yellowish-brown loamy fine sand which passes, at a depth of 18 inches, into yellow fine sandy loam or loamy fine sand that continues to a depth of several feet and contains a large quantity of hard concretions of calcium carbonate.

A very large proportion of this soil, especially in the southern part of the county, is in cultivation. Although this is a rather light textured soil, much of the land, possibly one-half, is sowed to wheat which yields 6 or 8 bushels an acre in normal seasons. Grain sorghums are grown to a slight extent, and they produce probably about 10 or 12 bushels an acre. The grain sorghums, sorgo, and Sudan grass produce small yields of forage. Some corn is grown on the flat smooth areas which lie between the undulating higher areas. Here the water table is higher, and probably underground seepage supplies some moisture from the higher land. Vegetables, fruits, berries, melons, peas, grapes, and peanuts grow well and produce moderate yields on the smoother areas. Some small and a few large apple orchards are producing well on this soil in the southwestern part of the county. Such trees as locust, cottonwood, and catalpa are grown in small plantings and make a very rapid growth.

The native vegetation on this soil consists largely of coarse bunch grasses, chiefly the bluestems, grama, and some others. The soil is low in organic matter, and doubtless nitrogen and phosphorus are lacking.

Reinach loamy very fine sand.—The 12-inch surface soil of Reinach loamy very fine sand is grayish-brown loamy very fine sand. It grades into reddish-brown loamy very fine sand or very fine sandy loam, which is not calcareous. At a depth of about 3 feet, this material changes to reddish-brown calcareous very fine sandy loam. In places beds of red calcareous coarse sandy loam containing some fine gravel occur at a depth of 3½ or 4 feet.

Reinach loamy very fine sand is not extensive, but it occupies a number of small areas a few miles northwest of Jet, occupying smooth high terraces adjacent to the Great Salt Plains. A fair-sized body borders Salt Fork Arkansas River.[4]

The relief of this soil is very smooth and almost flat. The land has very good surface drainage and underdrainage, although the water table is high in the section around the Great Salt Plains. In some wells, water is reached at a depth of 8 or 10 feet.

This soil is fairly productive, and most of it is farmed. It is used largely for the production of wheat, although some grain sorghums, corn, and alfalfa are grown. Yields are lower than on Yahola fine sandy loam. They probably average about 10 bushels of wheat, 15 bushels of grain sorghums, and 1¾ tons of alfalfa hay an acre.

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[4] Areas of Reinach loamy very fine sand in Alfalfa County join areas in Grant County correlated as Grant loamy very fine sand. Recent information indicates that the correlation in the Reinach series is more consistent.

ALLUVIAL SOILS

The alluvial soils of this county comprise narrow strips of low first-bottom soils along the streams. They are not of great extent and, although fairly productive in many places, are not everywhere first-class crop-producing soils because of the very sandy light texture of the subsoils in some places. Where deep, with fairly heavy subsoils, these soils are highly productive and are used largely for alfalfa, corn, and other feed crops, and in places a small acreage is devoted to small grains, chiefly wheat. These soils are subject to overflow which sometimes causes injury to growing crops. Much of the land is in cultivation, but in some places the subsoil is too light for the production of high or even moderate yields.

Yahola silty clay loam.—The 10-inch surface soil of Yahola silty clay loam is reddish-brown, brownish-red, or chocolate-brown calcareous silty clay loam. It has a mellow smooth feel and a rather friable consistence, but on drying it packs tightly in uncultivated fields. This material gradually passes into a subsoil that consists essentially of alternating layers of light- and heavy-textured red calcareous soil materials. In places the subsoil is red calcareous very fine sandy loam which grades into lighter sandy material, and in other places it is red silty calcareous clay which extends to a depth ranging from 15 to 24 inches beneath the surface, where it rests on red calcareous very fine sandy loam or fine sandy loam. The subsoil material below a depth of 3 feet is, in many places, very light fine sand, and in a few places the sand lies within 2 feet of the surface. This soil is composed of successive layers of soil materials which differ in texture, according to the volume and velocity of the overflow waters that deposited the materials. The sediments comprising the soil materials have been washed from areas of soils and formations of the Red Beds, and these are largely calcareous.

Yahola silty clay loam occurs in the flood plains of some of the larger streams of the county that drain Red Beds areas. The largest bodies are along Medicine Lodge River, Mule Creek, and Eagle Chief Creek. Small spots of Yahola silty clay, Miller silty clay, and Yahola very fine sandy loam are included within areas mapped as Yahola silty clay loam.

Although this soil is overflowed occasionally, water does not remain long on the ground and drainage is sufficiently free to insure the production of crops with little loss from overflows. The water table lies only a few feet beneath the surface; moisture conditions, therefore, are more favorable for crops than on the higher lying more sloping soils. Such crops as alfalfa and corn grow better here than on the upland soils.

Most of this soil is in cultivation, and wheat, alfalfa, and corn are grown, together with some sorghums and other crops. Wheat produces well, although in seasons of considerable rainfall it makes a very rank growth of stalk. Probably the yield averages about 15 bushels an acre. Alfalfa produces an excellent growth, and yields range from 2 to 3 tons of hay a season from three or four cuttings. Corn on the better areas yields from 30 to 50 bushels an acre when moisture and temperature conditions are favorable, but in some fields where the surface soil is thin yields are lower. Sometimes droughts

in summer affect corn on this soil as well as on the uplands. Grain sorghums yield from 15 to 30 bushels of grain an acre and in addition considerable coarse forage. Sudan grass and sorgo produce good yields of hay and coarse forage. Crop yields on this soil vary largely in proportion to the thickness of the heavy subsoil layers. In places where the subsoil is mainly sandy material the yield is much less than where the subsoil contains a layer of clay or clay loam.

Yahola very fine sandy loam.—Yahola very fine sandy loam has a surface soil of reddish-brown calcareous very fine sandy loam ranging from 10 to 15 inches in thickness. The material in this layer grades into red calcareous very fine sandy loam or loamy very fine sand, which is continuous to a depth of several feet, though in places the material below a depth of 2 or 3 feet is fairly loose fine sand.

This soil occupies the bottom lands along many small streams as well as the flood plains along the larger streams. The texture and thickness of the soil layers differ considerably from place to place, in proportion to the variable influences of water deposition. The soil materials comprise sediments deposited from overflow waters of streams draining the Red Beds. The land is overflowed occasionally, but, as a rule, natural drainage is sufficient to allow successful cultivation. In most of this soil the water table lies at a slight depth, and moisture conditions are favorable for crops except in places where the subsoil contains a very large proportion of loose sand. This soil occurs mainly in the southeastern part of the county.

Most of the land is in cultivation, and it is used for the production of wheat, alfalfa, and various other crops. Yields range from good to very low in proportion to the heaviness of the subsoil, as in places this underlying material is so porous and devoid of fine earth material that underdrainage is excessive and the soil leached of plant nutrients. In the better areas, alfalfa yields an average of 2 tons an acre, and corn yields from 15 to 25 bushels. Grain sorghums, sorgo, and Sudan grass produce good yields. This soil is suited to vegetables and small fruits.

Much of the land along the small streams includes a narrow strip of steep gullied untillable soil along the stream bank, which renders some small fields unsuitable for cultivation because of the difficulty, or impossibility, of moving farm machinery across the steep banks.

Yahola fine sandy loam.—The surface soil of Yahola fine sandy loam is brown fine sandy loam from 8 to 12 inches thick. It is underlain by reddish-brown fine sandy loam or loamy fine sand, which, in places, below a depth ranging from 2 to 3 feet, grades into yellow loose fine sand. Both surface soil and subsoil, as a rule, are calcareous. In places thin layers of clay or clay loam occur in the sandy subsoil.

This soil is not extensive. It occupies a number of small areas in the northern part of the county, chiefly along Medicine Lodge River [5] and Sandy Creek.

The soil is rather light and loose in most places, and it varies in productiveness largely in accordance with the character of the sub-

[5] Along Salt Fork Arkansas River small bodies of Yahola loamy sand are not sufficiently important to show separately and are included with areas of Yahola fine sandy loam; therefore an area of Yahola fine sandy loam in Alfalfa County joins an area mapped as Yahola loamy sand in the adjoining Grant County at the county line.

soil. In areas where layers of heavy soil are in the subsoil, the land yields much better than in those where the subsoil is very light sandy material. The principal crops grown are wheat, alfalfa, corn, and sorghums. Yields are approximately the same, or not quite so high, as those obtained on Yahola very fine sandy loam.

VERY LIGHT LOOSE DEEP SANDS

The group of very light loose deep sands includes deep sandy soils containing very little loamy material in either surface soil or subsoil. These soils are the lightest and most sandy soils of the county and in places have a dunelike configuration, indicating drifting and reworking by action of the wind. They are not very well suited to the production of farm crops, but in the smoother situations some sorgo, grain sorghums, and other coarse feed crops can be grown. Very small acreages of these soils are cultivated.

Enterprise fine sand, dune phase.—The surface soil of Enterprise fine sand, dune phase, is light grayish-brown very slightly loamy fine sand ranging in thickness from 6 to 12 inches. The material changes gradually, with increase in depth, to yellow or brownish-yellow loose fine sand that continues to a depth of many feet. The relief is very uneven, as it is characterized by many small and large mounds of dunelike appearance, doubtless of wind-blown origin. In the intervening depressions between the mounds and dunes the land is flat. The soil in such areas, ranging from a few square yards to several acres in extent, though a fine sand, is darker and more loamy than that on the mounds. The mounds are covered with coarse vegetation which holds the soil and prevents drifting in the heavy winds. The chief grasses are coarse and tall bunch grasses, largely little bluestem, sandreed grass, and some grama. In the southern part of the county, a fairly thick growth of small blackjack oak trees, some stands covering a hundred acres or more, occurs on this soil; but in the northern part none of these trees were seen on this soil during the course of the survey.

This soil occupies large areas in different parts of the county. The largest is in the extreme northeastern part and covers many square miles. Other bodies are north of Salt Fork Arkansas River in the northwestern part, and numerous smaller areas are a few miles southeast and southwest of Aline in the southwestern part.[6]

This deep loose sand constitutes old water-laid deposits that have been reworked and shifted by the winds, although at present all the land not plowed is held by the native vegetation. A very large proportion of this soil is entirely unsuited to cultivation. In places small acreages of the less dunelike areas have been plowed and some cropping done, but most of the mounds, some of which range from 20 to 30 feet in height, are entirely too steep for cultivation.

This soil is very thin and is low in productive capacity. It is associated with Pratt loamy fine sand which is smoother and slightly heavier and, therefore, better suited for cultivation. The dune phase

[6] Enterprise fine sand, dune phase, at the county line between Alfalfa and Grant Counties, joins areas mapped as Derby sand in Grant County. As eastern Alfalfa County is the arbitrary line of separation between Pedocals and Pedalfers, soils of the two representative series meet.

of Enterprise fine sand should be left in grass or trees, as it drifts severely in heavy winds where unprotected. Probably trees would produce very good yields of posts and small timber, as they seem to grow very well, probably because of the moist subsoil conditions in the flats between the mounds. Nearly all of the land is used for pasture, but it is not very valuable for this purpose, as the grasses are thin and not highly nutritious. Paths worn by livestock finally result in the formation of blow-outs, therefore grazing should be carefully controlled.

Pratt loamy coarse sand.—The surface soil of Pratt loamy coarse sand is brown loamy coarse sand. It is underlain, at a depth of about 10 inches, by reddish-brown or yellowish-brown loamy coarse sand which continues to a depth of many feet. The surface soil and subsoil have a large content of coarse sand and some very fine quartz gravel. The proportion of coarse material increases gradually with depth. The surface soil contains considerable very fine sand, and this, together with a small content of silt, gives a very slight coherence.

This soil occurs on a long ridge about a mile wide extending from Jet northeastward to the river. The relief is rolling and billowy, indicating drifting of the soil material in heavy winds. Probably less than one-half of this soil is cultivated, owing to its very light coarse texture and low productive capacity. It is surrounded by smoother benchlike areas of Pratt sandy loam.

Small acreages are devoted to wheat, and some corn and sorghums are grown, but yields are light. Probably not more than 5 or 6 bushels of wheat an acre are produced on the smoothest areas. The land supports a good growth of coarse grasses, largely bluestems, some black grama, and various others, all of which produce fairly good pasturage.

THIN SOILS OF SLIGHT DEVELOPMENT

The only soil of this group mapped in this county has developed chiefly from Red Beds materials—largely calcareous clay or sandy clay and shaly clay. Owing to erosion, the surface soil washes away faster than the processes of soil development can form thick soil layers, and the subsoil material, which consists chiefly of the parent formation, is only slightly, if at all, changed from its original condition.

Vernon very fine sandy loam.—The 5- to 10-inch surface soil of Vernon very fine sandy loam is red or brownish-red very fine sandy loam. It grades into red calcareous very fine sandy clay or shaly clay, which constitutes the Red Beds materials that lie near the surface and in places outcrop on the steeper slopes. This is a very thin immature soil which has changed but little, even in the upper layers, from the original parent material. It is very shallow, and the land is sufficiently sloping to cause severe sheet erosion and the formation of deeply cut vertical-walled gullies. On some fairly broad divides the relief is moderately smooth, but even in such places the true soil material is shallow. As the relief is undulating or rolling, much of the rain water runs off and does not penetrate the soil deeply.

Vernon very fine sandy loam occupies many small areas in the southern part of the county. The largest are a few miles east of Carmen adjacent to a high escarpment formed by the Red Beds outcrops.[7] Associated with this soil are a number of small areas of Vernon clay loam, which are not sufficiently important or valuable to show separately on the soil map.

Although Vernon very fine sandy loam is a soil of limited usefulness and of low value for the production of crops, a very large proportion of it is in cultivation. Much of the land probably would be better suited for pasture than for cultivation, although on the smoother areas some grains are grown and some feed crops do fairly well, even though, in some seasons, moisture is inadequate for the production of good yields. Reported acre yields of wheat are from 6 to 8 bushels; oats, from 15 to 20 bushels; and grain sorghums, from 12 to 15 bushels. This soil is not well suited to corn or alfalfa, not only on account of the low content of some essential plant nutrients but because of the unfavorable moisture conditions. It is probably low in nitrogen and in available phosphorus.

SALINE SOILS

There are areas of smooth well-developed soils which, though physically suited to cultivation, contain such quantities of soluble salts that normal growth of farm crops is more or less affected and in some places is impossible. These soils contain a moderate supply of plant nutrients and in places produce fair yields of crops, but in other places yields are very low. In some spots the soils have dense subsoils of claypan character. In places thin layers of white salt incrustations are on the surface or on the exposed surface of the soil material in deep cuts. Most areas support a characteristic growth of saltgrass. Small areas of these soils are in cultivation.

Drummond very fine sandy loam.—Bordering the Great Salt Plains area are a number of small and large bodies of very low flat salty soil which, though lacking uniformity in texture and in profile features, has major soil characteristics that are fairly uniform. This soil is Drummond very fine sandy loam. It consists of a thin layer of fine sand or very fine sand over a thin layer, or tough claypan, of sandy clay which grades into sand and coarse material, in which the water table lies within a depth of a few feet from the surface. The material is more or less calcareous, especially in the lower layers, and contains salts, of which calcium sulphate, calcium carbonate, and sodium chloride seem to be abundant. The soil layers differ considerably in texture and thickness.

In an area about 2½ miles northwest of Jet, the surface soil consists of a gray loamy very fine sand layer about 1 inch thick, underlain by slightly lighter gray loamy very fine sand which appears to be light gray in the lower 1 inch. In virgin areas the surface soil material is somewhat laminated when dry. This material is abruptly underlain by a claypan of very dark brown or nearly black hard

[7] Along the Grant County line, Vernon very fine sandy loam joins areas mapped as Grant very fine sandy loam, shallow phase, in Grant County. As a result of further study, this soil is now correlated in the Vernon series.

tough clay. When pulverized the material shows a large content of very fine sand which is so strongly cemented as to form a dense claypan. This material, in turn, grades, at a depth of about 15 inches, into yellow heavy very fine sandy loam or sandy clay loam, which, though very hard when dry, is much less tough than the material in the layer above. In places this material is calcareous. At a depth ranging from 24 to 30 inches, it grades into reddish-yellow calcareous coarse sandy loam containing some very fine quartz gravel. In places the material in this layer rests on brown clay containing gray spots at a depth of 3½ or 4 feet.

In an area 2 miles south of Byron this soil has a 4-inch grayish-brown very fine sandy loam surface layer resting on yellow clayey fine sand containing coarse quartz sand particles. On drying, the material hardens to a dense tight tough structureless mass resembling a claypan. Below a depth of 18 inches the material is yellow coarse sand. The soil in this area supports much saltgrass (*Distichlis* sp.) and an abundant growth of hairy or tall bentgrass (*Agrostis* sp.). The water table here is about 6 feet below the surface.

In places the gray surface soil is only 1 or 2 inches thick, and in most places the subsoil is calcareous. This soil dries to a very hard tight condition, and only a very few small patches are cultivated. Wheat is the principal crop grown, and yields are low. The soil is used mainly for pasture, and some grass is cut for hay.

Many areas of this soil occur along the northern side of the Great Salt Plains in the northeastern part of the county. The largest bodies are a few miles south and southeast of Byron. Smaller areas lie along the southern side of the Great Salt Plains, and the largest of these is a few miles north of Jet. A number of small bodies and long narrow strips are in some of the small stream valleys in the southeastern part of the county. Some of these seem to be less salty, and the soil material is somewhat thicker than in the large areas near the Great Salt Plains.

Kay very fine sandy loam, saline phase.—The 10-inch surface soil of Kay very fine sandy loam, saline phase, is dark-brown calcareous very fine sandy loam. It grades into brown calcareous clay loam or heavy very fine sandy loam, containing soft white particles. At a depth of 24 inches, this material, in turn, passes into reddish-brown or brown calcareous fine sandy loam or clay loam containing numerous white lumps and particles, evidently calcium carbonate ($CaCO_3$), calcium sulphate ($CaSO_4$), and possibly some sodium chloride (NaCl), which appear as white coatings on the sides of an exposed bank. Below a depth of 40 inches, the subsoil is grayish-brown calcareous very fine sandy loam containing much white chalky material and fine crystals of calcium sulphate. At a depth of about 80 inches, the material is very wet, indicating that the water table lies near this depth. In rainy seasons the water table rises almost to the surface.

This soil occupies a few areas in the vicinity of Cherokee on the high terrace occupied mainly by Reinach soils. The land supports some saltgrass and other grasses. In places small spots of salt-incrusted soil are bare of vegetation, but the surface soil in other

places shows no indication of salinity. The soil is fairly productive where the content of salt is not excessive. It is reported that the salty spots are less numerous than formerly, owing, perhaps, to better drainage conditions brought about by road grading and ditching along the roads. Some fields of alfalfa, wheat, and oats were growing well on this soil at the time the survey was in progress. In places crop yields are very good, especially where the saline condition of the surface soil is slight.

NONARABLE LAND TYPES

The nonarable types of land physically are unsuited for use in the production of farm crops. They cover a rather large total acreage. Some areas are well covered with grass and are suited to pasture for livestock, but others support practically no vegetation and are of no value for any agricultural purpose.

Rough broken land (Vernon soil material).—Rough broken land (Vernon soil material) comprises steeply sloping eroded Red Bed clays, shales, and sandy formations, which in many places are exposed on slopes and appear as outcrops on steep banks. Deeply cut steep-walled gullies extend to many parts of the eroded broken land. Much of this land occurs along the Red Beds escarpment, which enters the county from the west at a point 10 miles west of Cherokee, thence, facing eastward, extends in a southeasterly direction to the vicinity of McWillie. The rough land occupies many narrow slopes in the vicinity of this escarpment and also occurs along many small valleys and gullies in the southeastern part of the county. It includes many small areas of Vernon soils, mainly Vernon very fine sandy loam, which could not be shown separately on a small-scale map.[8]

Although some parts of this land are bare, most of them support a fairly heavy growth of valuable grasses consisting of some bluestem, grama, and buffalo grasses, and others of less importance. This is fairly valuable land for grazing, and most of it is used for that purpose in a number of small farm pastures. The land is unsuited for farming, and when any land within or near it is plowed, it erodes rapidly.

Riverwash.—Riverwash consists of loose sandy deposits along the insides of the bends of the streams, where the coarser sandy sediments carried in swollen waters are deposited as bars and mounds on the flood plain nearest the stream. This material is largely loose gray sand and fine gravel, although in swales and pot holes some sediments accumulate as a thin veneer of silt and clay. The material is deposited in undulating ridges or as level smooth beaches. It is subject to change, reassortment, and general rearrangement at every overflow that covers the surface. Much of the land is bare of vegetation, but some areas support a thin scattered growth of willows, cottonwoods, various coarse grasses, herbaceous plants, and a few

[8] Areas of rough broken land in Grant County adjoining were correlated as Grant very fine sandy loam, eroded phase, and some of the rough broken areas in the two counties join at the county line. The later correlation, used in Alfalfa County, is now the accepted name.

shrubs. Riverwash of this character is of very slight extent in this county and has no value for cultivated crops.

Included with riverwash is a large area, locally known as the Great Salt Plains, which consists of a large lake basin lying only a few feet lower than the surrounding almost flat broad old terraces bordering it. This plain is dry most of the time, although at one side the channel of Salt Fork Arkansas River runs through this desert waste of salty land. The fine-earth material of this old lake bed consists of brown or yellowish-brown calcareous loamy very fine sand or fine sand, containing white crystalline salts that form a white crust from ¼ to 1 inch thick on the surface. Gray silty clay occurs beneath the surface, in places at a depth ranging from 2 to 3 feet. The land supports no vegetation, and during some wet seasons small pools of water remain in places. It is reported by local engineers that the western side of the lake bed is about 21 feet higher than the eastern side where the river channel cuts through. The bed is about 5 miles wide from east to west, at the widest place, and about 8 miles long.

RECOMMENDATIONS FOR THE MANAGEMENT OF ALFALFA COUNTY SOILS[9]

The most important factor that will affect the future productivity of the soils in Alfalfa County is the gradual decrease in organic matter and nitrogen which occurs when crops are removed from the land or soil is lost by erosion. Wheat is the important cash crop in this county, and every farmer should realize that the continuous production of wheat on the same land is only a temporary type of farming. Nitrogen is removed from the soil when crops are harvested, and the income obtained from the sale of grain represents wealth derived from the exploitation of natural resources. Wheat can be grown without fertilization as long as the combined effect of natural fertility, the use of good seed, and good soil management will produce good yields.

As the total nitrogen and organic-matter content of different soils varies to a great degree, response from the growth of legumes will depend on the relation between the quantity of available nitrogen in the soil and the climatic factors that may restrict plant development. Decline in crop yields will occur most rapidly on those soils which do not have a high content of total nitrogen. Soils high in potential fertility will remain productive for a considerable period without the use of legumes in the cropping system, whereas it will be necessary to grow legumes or to apply nitrogenous fertilizers on less productive soils, in order to maintain an adequate supply of available nitrogen for plant development.

Loss of organic matter through soil erosion when torrential rains occur is an important problem on sloping areas of unterraced land not protected by a vegetative cover. Most of the land in this county used for cultivated crops, which has a slope greater than 2 percent, should be terraced, in order to control run-off. Many farmers

[9] By H. J. Harper, professor of soils, Agronomy Department, Oklahoma Agricultural and Mechanical College.

may not realize that a permanent system of soil fertility cannot be maintained unless farming systems are used which will preserve natural fertility by the control of soil erosion and by growing legume crops for replacing the nitrogen that is removed from the soil when the grain is harvested. Changes in the chemical composition of the soils of the county, which have occurred as a result of cultivation, are given in table 4.

TABLE 4.—*Loss of plant nutrients in soils of Alfalfa County as a result of cultivation*

[Average of 17 comparisons]

Condition of soil	Total nitrogen	Total phosphorus	Readily available phosphorus	Organic matter
	Percent	*Percent*	*Parts per million*	*Percent*
Virgin	0.114	0.042	142	1.94
Cropped	.072	.038	119	1.21
Loss through cultivation	.042	.004	22	.73

Soil samples collected from cultivated fields and from adjacent areas of pasture or meadow were analyzed, and results of examination show that the nitrogen content of the soils of this county has decreased 37 percent since cultivated crops have been grown. Very little phosphorus has been lost by tillage, and the readily available phosphorus in cultivated soils is still high enough for the production of maximum yields without phosphorus fertilization. As alfalfa can be grown on a considerable acreage, the problem of a deficiency of nitrogen can be easily solved if alfalfa is grown in a rotation with wheat or some other grain crop. Land not adapted to alfalfa can be improved by growing other legumes, such as vetch, cowpeas, or Austrian Winter peas. Legume crops do not add nitrogen to the soil when the soil moisture is low because of deficient rainfall, as the development of nodules is slight under such conditions, and the effect of the legumes on succeeding crops will be less than when nodules are abundant on the roots of the legume. Frequently wheat does not produce a good yield following alfalfa or sweetclover because of a deficiency of moisture in the subsoil and increased vegetal growth due to a high concentration of available nitrogen in the soil. If small grain is planted in wide-spaced rows late in the season, the harmful effect of the legume on the succeeding crop will be reduced greatly. Small grain planted in rows 14 inches apart will yield as much, under normal conditions, as when planted in narrow-spaced rows. The only objection to wide-spaced rows comes from farmers who want fall pasture, or those who must protect the land from wind erosion by planting small grain in rows 7 or 8 inches apart.

Leguminous crops cannot be recommended for soil improvement on any soil until the income from crops following the legume is equal to or greater than the income obtained from land planted continuously to a grain crop. Farmers who can utilize leguminous

crops for pasture or forage can increase the nitrogen content of their soils at a lower cost than farmers who grow legumes and obtain no income from the land except the increase in yield of subsequent crops.

Soil acidity is not an important problem in this county. Of 128 samples of surface soil analyzed, 77 contained free calcium carbonate, 32 were neutral in reaction and contained enough lime for the production of alfalfa and sweetclover, 8 were slightly acid, 2 were slightly acid +, and 9 were medium acid. The samples of medium-acid soils were from areas of sandy land which absorbs all the rainfall, and a high percentage of the lime and other basic materials have been removed by leaching.

The availability of phosphorus in the soils is comparatively high, although the total content of phosphorus in some of the sandy soils is low. Of 71 samples of surface soil analyzed for readily available phosphorus, 55 were very high, 14 were high, 2 contained a medium amount and none was low or very low, according to laboratory tests. The problem of phosphorus fertilization will not be important for general crop production in this county for a long time. Crop yields in this county frequently are limited by a lack of moisture, and this condition will prevent the extensive use of commercial fertilizers, such as sodium nitrate, ammonium sulphate, superphosphate, or complete mixtures, until more accurate experimental studies have been made to determine how and when the different materials should be applied, in order to obtain a maximum effect on plant development.

The results of studies on the chemical composition of typical soils are given in table 5. The acidity of the samples was determined electrometrically and the results recorded as pH values, and practically all the soils are either neutral or basic in reaction. These samples were taken from virgin areas, but additional tests which have been made indicate that no appreciable increase in acidity has occurred as a result of cultivation. The subsurface layers of these soils are less acid than the surface layers, and in many of the soils the subsurface layers contain small quantities of calcium carbonate which indicate that leaching has not been an important factor in soil development. The total nitrogen in these soils is not so high as the average for Oklahoma, although the fine-textured soils, such as Foard clay loam, are very high in potential nitrogen. The total phosphorus in all soils is comparatively low, although the availability of the phosphorus is high. Experiments indicate that phosphorus fertilization has not been profitable on these soils. Readily available phosphorus in the soils of the bottom lands is very high, compared with the average in the soils of the uplands. The soils of the bottom lands are well adapted to the production of alfalfa because of their high content of available nutrients, and conditions are also very favorable for the absorption of moisture and development of roots.

TABLE 5.—*Chemical composition of soils in Alfalfa County, Okla.*

SOILS OF THE UPLANDS

Soil type and sample number	Location	Depth	pH	Total nitrogen	Total phosphorus	Readily available phosphorus	Organic matter
		Inches		*Percent*	*Percent*	*Parts per million*	*Percent*
Nash very fine sandy loam:							
3477	NW¼ sec. 6, T. 24 N., R. 10 W.	0 - 4	7.7	0.081	0.028	120	1.79
3478		4 - 8	7.5	.072	.032	120	1.60
3479		8 - 18	7.5	.072	.028	100	1.26
3480		18 - 36	8.5	.055	.025	180	.46
3481		36+	8.9	.044	.033	340	.44
Grant very fine sandy loam:							
3482	NW¼ sec. 8, T. 28 N., R. 11 W.	0 - 6	7.8	.114	.043	260	2.35
3483		6 - 18	7.7	.095	.035	170	1.66
3484		18 - 36	7.9	.064	.036	170	1.19
3485		36 - 72+	8.5	.053	.041	360	.57
Vernon very fine sandy loam:							
3486	SE¼ sec. 3, T. 24 N., R. 11 W.	0 - 6	8.8	.106	.043	360	2.15
3487		6 - 14	8.6	.070	.040	220	1.99
3488		14 - 36	8.5	.042	.037	360	.88
3489		36+	8.9	.004	.032	150	.08
Enterprise fine sand, dune phase:							
3494	SE¼ sec. 2, T. 27 N., R. 10 W.	0 - 10	7.9	.025	.016	90	.99
3495		10+	8.2	.027	.018	60	.66
Foard clay loam:							
3501	NW¼ sec. 16, T. 28 N., R. 12 W.	0 - 4	7.0	.204	.049	230	4.87
3502		4 - 10	7.1	.133	.039	180	2.55
3503		10 - 18	7.4	.082	.034	180	1.68
3504		18 - 36	8.7	.032	.040	320	.84
3505		36 - 50	8.6	.027	.034	260	.62
Enterprise loamy fine sand:							
3506	NW¼ sec. 10, T. 27 N., R. 11 W.	0 - 5	8.3	.040	.041	210	1.08
3507		5 - 12	8.3	.032	.025	150	.37
3508		12 - 30	8.4	.022	.026	110	.55
Pratt loamy fine sand:							
3509	NW¼ sec. 5, T. 27 N., R. 9 W.	0 - 6	7.4	.039	.022	42	1.19
3510		6 - 24	7.2	.022	.020	36	.73
3511		24+	7.2	.014	.013	60	.44
Vernon very fine sandy loam:							
3513	NE¼ sec. 36, T. 24 N., R. 10 W.	0 - 10	7.2	.096	.031	90	.82
3514		10 - 42	7.9	.044	.029	120	.73
3515		42+	8.6	.029	.031	130	.39
Pratt fine sandy loam:							
3516	SE¼ sec. 33, T. 28 N., R. 12 W.	0 - 8	7.6	.078	.041	160	1.90
3517		8 - 20	8.1	.049	.030	100	1.19
3518		20 - 36	8.4	.036	.033	100	.77
3519		36 - 48	8.6	.047	.023	100	.91
3520		48+	8.7	.046	.031	100	.99
Grant very fine sandy loam:							
3521	SW¼ sec. 23, T. 24 N., R. 10 W.	0 - 2	7.6	.142	.042	130	3.70
3522		2 - 10	7.6	.106	.030	110	2.52
3523		10 - 24	7.1	.075	.045	70	1.50
3524		24 - 36	7.1	.046	.029	70	.86
3525		36 - 60	7.8	.020	.029	180	.46
3526		60 - 72	8.7	.018	.035	220	.33
3527		72+	8.6	.025	.034	260	1.99
Nash very fine sandy loam:							
3534	NE¼ sec. 22, T. 25 N., R. 10 W.	0 - 5	6.5	.052	.024	90	1.00
3535		5 - 20	7.3	.034	.018	48	.82
3536		20 - 36	7.4	.042	.016	40	.64
3537		36 - 60	7.6	.042	.018	40	.51
3538		60+	8.0	.029	.018	72	.33
Pond Creek silt loam:							
3539	NE¼ sec. 27, T. 24 N., R. 9 W.	0 - 5	7.1	.106	.028	112	2.17
3540		5 - 10	6.9	.058	.025	104	1.79
3541		10 - 24	7.6	.090	.028	104	1.53
3542		24 - 42	7.2	.088	.027	52	1.10
3543		42 - 72	7.2	.074	.032	120	.95
3544		72+	8.0	.046	.025	100	.82
Pratt fine sandy loam:							
3545	SW¼ sec. 11, T. 24 N., R. 9 W.	0 - 6	6.9	.068	.024	42	1.26
3546		6 - 18	7.2	.060	.019	40	.86
3547		24 - 36+	7.5	.032	.016	36	.55
Pratt loamy coarse sand:							
3548	SW¼ sec. 33, T. 26 N., R. 9 W.	0 - 18	6.8	.062	.020	68	1.10
3549		18 - 36+	7.4	.072	.009	20	.33
Pratt sandy loam:							
3550	NW¼ sec. 5, T. 25 N., R. 9 W.	0 - 8	7.0	.054	.019	60	1.22
3551		8 - 18	7.2	.076	.019	50	1.02
3552		18 - 42	7.4	.050	.014	16	.88
3553		42+	7.8	.070	.012	16	.48

TABLE 5.—*Chemical composition of soils in Alfalfa County, Okla.*—Continued

SOILS OF THE BOTTOM LANDS

Soil type and sample number	Location	Depth	pH	Total nitrogen	Total phosphorus	Readily available phosphorus	Organic matter
		Inches		*Percent*	*Percent*	*Parts per million*	*Percent*
Reinach very fine sandy loam:							
2910	NW¼ sec. 32, T. 29 N., R. 12 W.	0 - 18	8.4	0.051	0.034	160	1.45
2911		18 - 38	8.7	.093	.032	160	.90
2912		38 - 50	8.9	.082	.039	160	1.95
2913		50 - 66	8.4	.046	.033	160	.80
2914		66 - 90	8.3	.033	.038	160	.60
Reinach silt loam:							
3462	SW¼ sec. 11, T. 28 N., R. 12 W.	0 - 6	7.3	.081	.044	340	1.93
3463		6 - 22	7.6	.071	.040	280	1.41
3464		22 - 28	8.0	.073	.032	160	.95
3465		28 - 36	8.5	.040	.033	180	.80
3466		36 - 80	8.6	.025	.035	200	.40
3467		80 -120	8.9	.021	.041	300	.30
3468		120+	8.4	.014	.030	260	.88
Yahola silty clay loam:							
3469	NE¼ sec. 4, T. 27 N., R. 11 W.	0 - 8	8.4	.142	.050	340	2.46
3470		8 - 20	8.5	.098	.045	340	1.41
3471		20 - 36	8.5	.081	.048	280	1.13
3472		36+	8.6	.025	.036	360	.66
Amorita clay loam:							
3473	SW¼ sec. 6, T. 28 N., R. 11 W.	0 - 2	8.4	.202	.071	360	3.90
3474		2 - 12	8.6	.092	.050	280	1.66
Reinach very fine sandy loam:							
3475	SE¼ sec. 2, T. 25 N., R. 11 W.	0 - 12	8.8	.073	.046	360	1.66
3476		12 - 36+	8.7	.033	.042	280	.75
Yahola silty clay loam:							
3490	NE¼ sec. 35, T. 28 N., R. 11 W.	0 - 5	8.2	.207	.043	360	4.87
3491		5 - 10	8.1	.126	.036	280	2.53
3492		10 - 36	8.2	.033	.026	260	.82
3493		36+	8.2	.008	.015	140	.57
Drummond very fine sandy loam:							
3528	SE¼ sec. 1, T. 25 N., R. 10 W.	0 - 5	8.6	.086	.032	180	1.88
3529		5 - 7½	9.0	.060	.024	180	1.22
3530		8 - 14	9.4	.068	.031	150	1.28
3531		14 - 20	9.3	.018	.025	150	.51
3532		20 - 36	8.7	.018	.014	80	.53
3533		36+	8.7	.014	.015	60	.44
Drummond very fine sandy loam:							
3554	SW¼ sec. 5, T. 27 N., R. 10 W.	0 - 1	8.4	.062	.031	88	.99
3555		1 - 2½	8.9	.054	.032	60	1.08
3556		2½ - 8	8.8	.048	.033	186	.48
3557		8 - 18	8.6	.034	.033	192	.37
3558		18 - 24	8.6	.071	.029	192	.28
3559		24 - 30+	8.5	.048	.029	144	.17
Yahola fine sandy loam:							
3560	NE¼ sec. 25, T. 28 N., R. 10 W.	0 - 4	8.5	.070	.025	148	2.01
3561		4 - 10	8.6	.064	.024	142	1.15
3562		10 - 36+	8.6	.032	.015	90	.24

Wind erosion is not a serious problem in this county, except on rolling sandy land. Grain sorghums, cowpeas, and small grains planted in strips approximately 70 feet wide can be used to prevent serious damage to crops where the movement of sand on unprotected land is a constant menace to plant development. These crops may be grown in a 3-year rotation, but livestock are needed to utilize the feed and pasture produced under this system of cropping. Poor sandy soils should be used for pasture, even though it requires several years for a good stand of grass to develop on sandy land, where the native grass has been destroyed by cultivation.

Some salty soils occur on terraces and bottom land near the Great Salt Plains. In such areas surface evaporation should be reduced to a minimum and adequate drainage should be provided. No vegetation grows on some of these areas because of the high concentration

of soluble salts in the soil. Saltgrass is a good indication of salty soils where the natural vegetation has not been destroyed by tillage.

Silting of stream channels is a serious problem in some parts of the county. Good soils in the bottom land are affected by overflow which did not occur until the stream channels were filled with sand originating in adjacent areas of unprotected upland. Farmers who own bottom land should be intensely interested in a soil-conservation program, because poor management of soils on the upland eventually will injure good bottom land which is now highly productive.

Bindweed is gaining a foothold in many fields, and a vigorous attempt should be made to destroy it before it becomes a serious pest. Spraying the foliage with 300 pounds of sodium chlorate an acre in October is one of the most effective methods of control in the small areas, and in the larger areas it should be controlled by clean cultivation.

Improvement of the pastures is an important problem on many farms. The control of weeds, by frequent clipping or by grazing with sheep, followed by limited grazing until the grass recovers from the effects of severe drought and overgrazing is the only practical method for increasing the income from pasture land. Legumes cannot be introduced into native-grass pastures, consequently, the continued growth of grass must depend on the fixation of nitrogen by nonsymbiotic organisms.

PRODUCTIVITY RATINGS

In order to give definite evaluation of the productive capacities of the soils of the county, table 6 has been prepared to show as nearly as possible, by estimates made from reports of local farmers, the average acre yields, on each of the soils, of the more important crops grown. These estimates are to be considered as representing the inherent ability of the soils to produce under the climatic conditions of the section where they are cultivated and managed under the ordinary methods employed by the farmers. The same soils would, of course, yield somewhat differently in other counties under different conditions of climate and management.

TABLE 6.—*Estimated average acre yields of the principal crops grown on each soil in Alfalfa County, Okla.*

Soil type	Wheat	Oats	Grain sorghum	Sorghum forage	Alfalfa	Barley	Corn
	Bushels	*Bushels*	*Bushels*	*Tons*	*Tons*	*Bushels*	*Bushels*
Pond Creek silt loam	17	34	20	2	1½	20	22
Grant very fine sandy loam	16	------	20	2	1½	------	20
Nash very fine sandy loam	9	------	15	1	¾	------	------
Kay silt loam	18	36	20	2	2½	------	------
Reinach silt loam	18	32	18	2	2	20	------
Reinach very fine sandy loam	14	------	16	2	2	------	------
Reinach silty clay loam	15	30	18	2	2	------	------
Amorita clay loam	15	30	18	2	2	------	------
Foard clay loam	10	24	15	1	1	12	------
Pratt fine sandy loam	10	20	15	1	1	------	------
Carwile fine sandy loam	8	20	14	1	½	10	15
Carmen fine sandy loam	9	18	14	1	¾	------	------
Pratt sandy loam	10	18	13	------	------	------	------
Reinach fine sandy loam	12	------	15	2	1½	------	18
Enterprise loamy fine sand	7	15	12	1	1	------	------
Pratt loamy fine sand	7	15	12	1	------	------	51

TABLE 6.—*Estimated average acre yields of the principal crops grown on each soil in Alfalfa County, Okla.*—Continued

Soil type	Wheat	Oats	Grain sorghum	Sorghum forage	Alfalfa	Barley	Corn
	Bushels	*Bushels*	*Bushels*	*Tons*	*Tons*	*Bushels*	*Bushels*
Reinach loamy very fine sand	10		15		1¾		
Yahola silty clay loam	15		20	2	2		25
Yahola very fine sandy loam	8		15	1½	1½		20
Yahola fine sandy loam	6		15	1½	1		15
Enterprise fine sand, dune phase							
Pratt loamy coarse sand							
Vernon very fine sandy loam	6	15	12	1			
Drummond very fine sandy loam							
Kay very fine sandy loam, saline phase							
Rough broken land (Vernon soil material)							
Riverwash							

In order to present ratings of the soils in comparison with the best soils of the United States for each crop, table 7 gives the percentage standing of each soil in the county for each crop. The standard of 100 percent represents the best average acre yield for each crop on the soils of the United States best suited to that crop. These yields have been determined as follows: Wheat, 25 bushels; rye, 25 bushels; barley, 40 bushels; oats, 50 bushels; grain sorghums, 40 bushels; sorghums for forage, 4 tons; alfalfa, 4 tons; and pasture, 100 cow-acre-days. All yields, both the standard and those given for each soil in the county, are for crops grown without irrigation, drainage, or the addition of fertilizers or other soil amendments. The ratings for the soils of the county are based on the average yields given in table 6. These ratings are, of course, only approximate.

TABLE 7.—*Rating of soils in Alfalfa County, Okla., according to productivity, as based on average yields compared to the standard for the United States*

Soil type	Wheat	Oats	Grain sorghum	Sorghum forage	Alfalfa	Barley
Pond Creek silt loam	68	68	50	50	38	50
Grant very fine sandy loam	64		50	50	38	
Nash very fine sandy loam	36		38	25	19	
Kay silt loam	72	72	50	50	64	
Reinach silt loam	72	72	45	50	50	50
Reinach very fine sandy loam	56		40	50	50	
Reinach silty clay loam	60	60	45	50	50	
Amorita clay loam	60	60	45	50	50	
Foard clay loam	40	48	38	25	25	30
Pratt fine sandy loam	40	40	38	25	25	
Carwile fine sandy loam	32	40	35	25	12	25
Carmen fine sandy loam	36	36	35	25	19	
Pratt sandy loam	40	36	33			
Reinach fine sandy loam	48		38	50	38	
Enterprise loamy fine sand	28	30	30	25	25	
Pratt loamy fine sand	28	30	30	25		
Reinach loamy very fine sand	40		38		44	
Yahola silty clay loam	60		50	50	50	
Yahola very fine sandy loam	32		38	38	38	
Yahola fine sandy loam	24		38	38	25	
Enterprise fine sand, dune phase						
Pratt loamy coarse sand						
Vernon very fine sandy loam	24	30	30	25	25	
Drummond very fine sandy loam						
Kay very fine sandy loam, saline phase						
Rough broken land (Vernon soil material)						
Riverwash						

It will be noted that the ratings of the soils are rather low as compared to average acre yields for the best soils of the United States for various crops. This is not altogether due to the lack of suitability of the soils in this county for these crops, or to the low inherent capacity for production of many of the soils, but it is due in large part to the irregularity of the moisture supply because of low rainfall during some years and some seasons. Many of the soils have the capacity to rate 100 percent when moisture conditions are favorable. As the rating is based on average yields for a long period of years, an occasional droughty season greatly reduces the average yield of crops. The yields and ratings of the same soils may differ in adjoining counties because of slight or considerable differences in the local environment which may affect crop yields.

MORPHOLOGY AND GENESIS OF SOILS

Alfalfa County lies at the eastern edge of the Great Plains where this great physiographic area merges with the northern prairies. The soils of the county, therefore, have been developed under a grass cover in a climate characterized by comparatively low rainfall and moderate temperature. Such an environment provides conditions giving rise to soils of pedocalic character; that is, the normal soils have developed a profile containing a distinctive layer, or horizon, in which a comparatively large quantity of segregated calcium carbonate has accumulated. This characteristic horizon occurs beneath the smooth soils of advanced development, but, owing to the location of this county near the eastern margin of the region of pedocalic soils, this horizon is not well developed and the proportion of carbonates accumulated is less than in the pedocalic soils farther west. This is because of the higher rainfall here and, therefore, greater leaching effect than occurs in the drier section farther west. The horizon of calcium carbonate accumulation ranges from several inches to 2 feet in thickness beneath the smoother and more mature soils that have normal development, and it lies at a depth ranging from 3 to 5 feet beneath the surface.

The horizon of calcium carbonate accumulation is not distinctly developed in this county and is entirely absent in soils that include characteristics which are not normal, such as deep loose sands, that allow rapid and exhaustive leaching; alluvial soils, that are subject to periodic overflows which prevent normal development; and soils that have rather steeply sloping or even moderately sloping relief, where removal of the soil layers by washing prevents the formation of normal layers in the surface soil and subsoil.

The normal soils of the pedocalic region in this section of the State are typically dark, contain a moderate quantity of organic matter, and have a crumbly structure with some developed granulation in the upper part of the subsoils. They are similar in character to soils known as southern Chernozems and are here considered as representatives of those soils, which are the normal dark-colored soils of the eastern edge of the pedocalic region. In this county, only in some of the smooth soils having heavy texture and undisturbed by excessive erosion does this well-developed Chernozem, or development of a dark soil, occur.

Some of the smooth moderately heavy soils show the best evidences of pedocalic development. The loamy light-textured soils and the deep sandy soils show little evidence of such development, as their light porous structure allows such rapid leaching. The very loose deep sands are zonal in character. The frequent inundations and periodic depositions of soil material prevent the alluvial soils from showing development of any appreciable characteristics imposed by the environment. The saline soils and the thin soils of slight development are intrazonal. The saline soils show no evidence of an accumulation of calcium, but, owing to imperfect underdrainage and, probably, a high water table, the accumulation of soluble salts throughout the soil mass has produced soil characteristics that differ from the normal. The thin soils of slight development are eroded so rapidly that only the early stages of soil development have taken place.

The moderately heavy smooth upland soils have developed largely from Red Beds material and also from old alluvial deposits, probably of both Quaternary and recent time. The light sandy soils have developed under very coarse grasses from deep loose sands of both Quaternary and recent time. These sands have, in places, been shifted by winds, and very little soil development has taken place in them.

The soils of the Pond Creek, Grant, Nash, and Foard series constitute the most maturely developed soils of Alfalfa County, and they reflect well the representative stages of soil development in the western part of Oklahoma, the dark-earth section of the region of pedocalic soils. These soils have developed largely from Red Beds material, chiefly calcareous clay, shaly clay, and sandy clay beds, though in places a thin mantle of old water-laid heavy Quaternary material over the Red Beds seems to have contributed to the soil parent materials.

Of these, probably the Grant and Pond Creek soils represent the more nearly normal soils of the county. The Grant soils occupy slightly undulating areas and have good surface drainage and underdrainage. These soils do not have the distinct layer of calcium carbonate accumulation so well developed as it is in soils lying west of this county. In a deep cut near Cherokee where the soil horizons are exposed, the representative soil profile of Grant very fine sandy loam is as follows:

0 to 6 inches, brown very fine sandy loam which is slightly laminated and grades through a gradual change into the layer below.

6 to 16 inches, heavy brown clay loam containing a few fine quartz gravel and granular crumblike fragments ranging from one-eighth to one-fourth inch in diameter. When dry the material is packed tightly in a mass, and it breaks apart naturally into columnar slabs. The fine aggregates are coated with dark gray, but when crushed the soil material is rich brown.

16 to 24 inches, brownish-red crumbly clay containing a few fine quartz gravel.

24 to 38 inches, yellowish-red crumbly calcareous clay containing a few water-worn rounded gravel and fine concretions of calcium carbonate. This is the zone of carbonate accumulation. The soil development here is very slight and in other places is even less well defined.

This material rests on a bed of fine gravel and coarse sand, which, at a depth of several feet, rests on calcareous Red Beds material.

In places, the Red Beds material lies only a few feet beneath the surface and no gravel bed is in the substratum. The material in all horizons is not acid but is about neutral in reaction.

Associated with Grant very fine sandy loam but occupying smoother more nearly flat areas is Pond Creek silt loam. This is a darker soil than the Grant soil, as it occurs in smoother areas and probably had originally a heavier growth of the short grasses because of slightly more moisture collected and retained from the rainfall. It has been developed from Red Beds material, but in places a thin surficial layer of a later water-laid formation has contributed, at least in part, to the soil parent material. Pond Creek silt loam occupies high nearly flat areas, although surface drainage and underdrainage are sufficiently free to allow thorough aeration of the entire solum. This soil has been developed deeply. A typical profile is as follows:

0 to 10 inches, dark-brown silt loam which is slightly laminated in the upper part. The material is structureless and packs to a hard mass on drying, but it shatters readily to irregular fine clods.

10 to 24 inches, very dark brown heavy very fine sandy loam or silt loam. The material in this horizon is darker than that in the horizon above. On drying, it separates to approximately columnar forms with smooth horizontal or transverse separation; it ranges from slightly granular to very granular, with the crumblike grains adhering tightly. These grains are very dark on the outside but brown within. Root penetration is deep, and the material contains many worm holes. The material is not calcareous but is about neutral in reaction.

24 to 40 inches, dark-brown or reddish-brown crumbly but rather heavy clay which is slightly columnar in structure, with irregular vertical cracks. It is very slightly granular, and the particles are angular though rough and not slick.

40 inches +, reddish-brown blocky clay composed of sharp slick particles.

In places, a zone of calcium carbonate accumulation lies at a depth ranging from 4 to 5 feet beneath the surface. This zone is 1 or 2 feet thick and consists of calcareous grayish-brown clay containing white chalky material, largely as small concretions of calcium carbonate.

Nash very fine sandy loam is a red soil developed from Red Beds materials under a grass cover on sloping relief, where erosion is sufficient to prevent maturity of development. It consists of a soil intermediate in development between the Vernon and the Grant soils, and it retains much of the color of the parent material. The soil horizons are not thickly developed. A typical profile is as follows:

0 to 10 inches, reddish-brown or brownish-red very fine sandy loam which is very friable, is not calcareous though probably about neutral in reaction, and is of single-grain structure.

10 to 30 inches, red or brownish-red heavy very fine sandy loam which is friable and permeable and not calcareous. This passes into red sandy calcareous Red Beds materials.

This soil contains no accumulation of calcium carbonate in a definite zone, as its development is incomplete. The parent material lies from 2 to 3 feet beneath the surface.

The Pond Creek, Grant, and Nash soils are very crumbly and permeable and the thick deeply developed subsoils, although moderately heavy, allow free underdrainage.

The Vernon soils represent a stage of still less soil development than the Nash soils. They have developed from the Red Beds calcareous materials, but they are so thoroughly eroded that only the thin surface soil shows slight evidence of soil development, and the subsoil consists largely of Red Beds parent materials. The Vernon soils are calcareous, deriving their calcium carbonate from the parent rock. They have the color of the parent material which has changed but little.

One soil of the upland, having a markedly different kind of subsoil, is Foard clay loam, which is a flat dark claypan soil developed from Red Beds materials. A profile description of this soil is as follows:

0 to 6 inches, dark-brown clay loam.
6 to 20 inches, dark-brown tough hard clay. This is a claypan, though no gray layer occurs above it. On drying the material separates to large clods which are slightly blocky in places, and these separate into fine slick sharp particles.
20 to 32 inches, grayish-brown clay which is slightly calcareous in places.
32 to 50 inches, yellowish-brown calcareous clay containing hard small concretions of calcium carbonate. This is the zone of calcium carbonate accumulation. It grades into redish-yellow noncalcareous friable clay which is continuous to the Red Beds material lying at a depth of about 10 feet below the surface.

The Kay and Reinach soils have developed from recent water-laid materials on smooth flat terraces, which lie high above present overflow. These are deep well-developed soils but are not sufficiently mature to have developed a well-defined zone of calcium carbonate. The soil materials from which the Kay and Reinach soils have developed have been transported from soils of the western plains and largely from soils of the Red Beds materials. The original red color of the parent material remains largely in the Reinach soils, and some of the calcium carbonate has not been leached from the lower subsoil layers of both the Kay and Reinach soils. The Kay soils are very dark because they were deposited from comparatively quiet backwater containing fine soil materials with little sand. On account of the flat slowly drained surface, a heavier growth of grass was produced, causing deeper penetration of the decomposed organic matter. The Amorita soils also have developed from the old deep beds of water-laid materials on flat terraces, and they have dense heavy subsoils.

The light loose deep sandy soils have developed largely from highly siliceous materials composed of loose or slightly loamy sand. This sandy material, probably of Quaternary age, shifts in the winds, and the loosest has very little true soil development, other than the slightly dark thin surface soil. This slight degree of soil development is represented by Enterprise fine sand, dune phase, and Pratt loamy coarse sand. These soils have been thoroughly leached and have no developed layer of carbonate accumulation. In this county the Pratt soils are slightly more loamy than the Enterprise soils. They support a moderate growth of grasses, but they have no zone of calcium carbonate accumulation and no developed texture profile. The Enterprise soils comprise loose deep permeable soils of the pedocalic region, that have no developed texture profile and are almost neutral in reaction. For the most part, they have no well-developed layer of calcium carbonate accumulation. Owing to the fact that the line

between the pedocalic and the pedalferic soil regions is arbitrarily placed at the eastern boundary of Alfalfa County, the areas mapped as Derby soils in Grant County along the boundary adjoin soils of the Enterprise series in Alfalfa County.

Loamy light sandy soils, which have developed from sandy materials of Quaternary age and from recent materials, are Pratt loamy fine sand and Pratt fine sandy loam. These soils have developed predominantly from sands containing a larger assortment of minerals (probably including feldspar) than the looser deep sands, and the minerals have produced the decidedly loamy texture of the soil material. These soils lie chiefly in the pedocalic area and have in places a slight accumulation of calcium carbonate in the form of hard concretions in the lower part of the solum, though in many places this is very indistinct. Carwile fine sandy loam occupies flat areas within the larger bodies of Pratt soils and, owing to slow underdrainage and probably a high water table providing an abnormally large amount of subsoil moisture, the subsoil is mottled gray and yellow, including imperfect aeration, and the surface soil is very dark, due to a heavier growth of the coarse native grasses which provide a large supply of organic matter. The areas of this soil are rather small, but they are distinctly different from any other soil in the county.

Carmen fine sandy loam is very similar in profile characteristics to Pratt fine sandy loam, but it differs in having a large amount of calcium carbonate concretions throughout the subsoil and in places in the surface soil. Possibly this is due to a local condition of seepage from slightly higher lying areas of deep sands, as the water passing below the sands over calcareous Red Beds on which the sands are imposed collects a large amount of the carbonate. The water gradually evaporates from the surface leaving the calcium carbonate in the form of concretions in the solum.

Reinach loamy very fine sand and Reinach fine sandy loam are sandy soils developed on the high old alluvial terraces no longer subject to overflow.

The saline soils are represented mainly by Drummond very fine sandy loam which borders the Great Salt Plains on low flat benches a few feet higher than the plain. These soils evidently are impregnated with soluble salts that tend to cause a dense compact condition of the subsoil, resulting in a claypan or Solonetz type of structure. At a point 2½ miles northwest of Jet the soil profile of Drummond very fine sandy loam shows the following layers:

0 to 1 inch, dark-gray loamy very fine sand intermixed with fine organic debris of native grasses.
1 to 5 inches, gray very fine sandy loam, in which the lower part, about 1 inch thick, is lighter in color than the material above.
5 to 8 inches, nearly black very fine sandy clay loam of claypan structure.
8 to 15 inches, yellow heavy very fine sandy loam. This is not a "pan," though on drying it is very hard.
15 to 20 inches, dark-brown heavy very fine sandy loam which is hard and compact.
20 to 25 inches, yellow heavy very fine sandy loam.
25 to 27 inches, brown gritty sandy clay.
27 to 40 inches, a bed of yellowish-brown coarse sand and fine rounded quartz gravel, which contains very little clay.
40 inches +, smooth nongritty yellowish-brown clay containing gray spots or lumps of salty material.

The white salts occur in small spots in places. The chief growth is saltgrass and a species of *Agrostis*. The depth of the water table ranges from about 8 to 10 feet below the surface in dry seasons.

The normal development of the intrazonal soils of the county, because of the influence of some local or general factor, is prohibited. Therefore, these soils are of immature development and do not have the characteristics imposed by the regional processes of development. These soils are extensive, but the areas productive of valuable crops are small. The extensive soils of intrazonal character are Enterprise fine sand, dune phase, and Pratt loamy coarse sand, both of which belong to the group of very light loose deep sands and consist largely of almost pure quartz sand. These soils leach rapidly, are readily and frequently shifted by winds, and support such a scant growth of native vegetation that no regional characteristics have developed.

The alluvial soils—members of the Yahola series—though valuable to greater or less extent for the production of crops, are azonal in that periodic inundations are constantly changing the character of the parent materials, thereby preventing normal development.

Vernon very fine sandy loam and rough broken land (Vernon soil material), are both azonal because of excessive washing away of the surface soil, which prevents normal development of a deep solum. These soils are fairly extensive. They are of little value for cultivated crops but support sufficient native vegetation to provide a moderate amount of good pasturage.

The saline soils, mainly Drummond very fine sandy loam, are more or less intrazonal because of the local conditions of poor underdrainage, which cause an accumulation of salts in the solum, and this has influenced the development of an unfavorable physical condition in some layers of the soil material.

Table 8 gives the results of mechanical analyses of two soils in this county.

TABLE 8.—*Mechanical analyses of 2 soils from Alfalfa County, Okla.*

Soil type and sample number	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
Pond Creek silt loam:	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
452047	0–6	0.1	0.2	0.3	1.1	15.7	66.5	16.2
452048	6–24	.0	.2	.2	.8	11.3	62.1	25.3
452049	24–42	.0	.2	.2	.2	12.3	59.4	27.8
452050	42–70	.0	.3	.3	.7	7.6	49.9	41.3
452051	72–80	.0	.4	.3	.9	10.7	48.9	38.9
Pratt sandy loam:								
452067	0–8	6.1	9.1	9.0	14.5	20.7	33.8	6.8
452068	8–18	10.1	11.1	7.9	11.4	16.4	34.3	8.8
452069	18–42	8.4	12.9	11.7	14.5	10.2	25.1	17.3

SUMMARY

Alfalfa County is an important agricultural county in northern Oklahoma. It lies at the eastern border of the subhumid climatic section and has a moderate average annual rainfall.

According to the census for 1930, the value of all field, orchard, and garden crops produced in 1929 was more than $4,000,000, of which the cereals, chiefly wheat, amounted to $3,540,531.

The Federal census for 1935 reported 367,036 acres, or 66.1 percent of the land in the county, available for farm crops. The same census reported 2,164 farms in the county, averaging 230.7 acres each, and having an average of more than 150 acres of land in cultivation. Because of the general smoothness of a large part of the land, it is well suited to the use of power machinery, and this, in conjunction with dry climatic conditions and the character of the soils, which are moderately heavy and of medium productiveness, provides conditions favorable for the production of small grain, principally wheat, which is by far the leading crop.

The soils over a large part of the county have smooth relief, silt loam or very fine sandy loam texture, and heavy permeable subsoils enabling the retention of a good reserve of soil moisture. These general characteristics are responsible for a generally prosperous agriculture. Large areas of soils with fairly high water tables and good physical characteristics are well suited to feed crops, especially alfalfa and sorghums. Large areas of loose deep sandy soils are of low value for farm crops.

Many of the soils are pedocalic, although the county lies so near the boundary between the Pedocals and Pedalfers that pedocalic characteristics are not well defined. The soils have been classified according to their physical and chemical characteristics and have been cataloged and systematically arranged in series and types for the purpose of convenient study and reference. In relation to their general characteristics, as related to their value and use in agriculture, the soils are arranged in groups which include approximately similar soil types and phases. These are moderately heavy smooth upland soils, loamy light sandy soils, alluvial soils, very light loose deep sands, thin soils of slight development, saline soils, and nonarable soils and land types.

The group of moderately heavy smooth upland soils includes the most extensive and the most valuable agricultural soils of the county—the very fine sandy loams, silt loams, and some clay loams of the Pond Creek, Grant, Nash, Kay, Reinach, Amorita, and Foard series. They are well suited to wheat and other small grains and to feed crops, including alfalfa, sorghums, and corn. Alfalfa is grown largely on the Reinach and Kay soils. Climatic conditions do not favor the production of corn, and very little is grown.

The loamy light sandy soils have loose sandy surface soils but moderately heavy subsoils. These soils have very favorable moisture conditions, owing to their ability to collect and retain a large proportion of the rainfall. They are rather too light in texture for the best production of small grains, but a very large proportion of them is used for the production of wheat. Although yields generally are not high, they are fairly consistent, and failures are rare. These soils are used largely for the production of grain sorghums and to some extent for corn. They comprise the fine sandy loams and loamy fine sands of the Pratt, Carwile, Carmen, Enterprise, and

Reinach series. They are rather extensive and occur in close association with one another in several sections of the county.

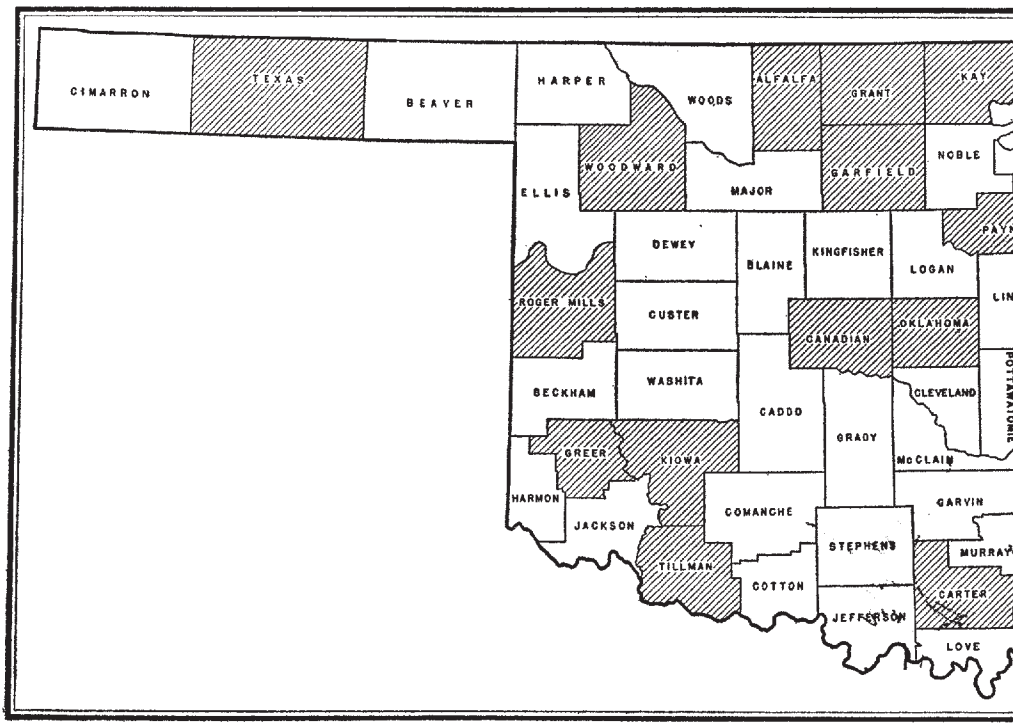
The very light loose deep sands are soils of the Enterprise and Pratt series. They are not very productive and generally are not used for cultivated crops. They drift in the strong winds where unprotected by growing vegetation.

The soils little used for farm crops but left for pasture are Vernon very fine sandy loam; the saline soils, mainly Drummond very fine sandy loam; and the nonarable land, including rough broken land (Vernon soil material) and riverwash.

U. S. GOVERNMENT PRINTING OFFICE: 1939

Authority for printing soil-survey reports in this form is carried in the Appropriation Act for the Department of Agriculture for the fiscal year ending June 30, 1933 (47 U. S. Stat., p. 612), as follows:

There shall be printed, as soon as the manuscript can be prepared with the necessary maps and illustrations to accompany it, a report on each soil area surveyed by the Bureau of Chemistry and Soils, Department of Agriculture, in the form of advance sheets bound in paper covers, of which not more than 250 copies shall be for the use of each Senator from the State and not more than 1,000 copies for the use of each Representative for the congressional district or districts in which a survey is made, the actual number to be determined on inquiry by the Secretary of Agriculture made to the aforesaid Senators and Representatives, and as many copies for the use of the Department of Agriculture as in the judgment of the Secretary of Agriculture are deemed necessary.



Areas surveyed in Oklahoma shown by shading. Detailed surveys shown by northea

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SOIL MAP
ALFALFA COUNTY
OKLAHOMA

OKLAHOMA AGRICULTURAL EXPERIMENT STATION
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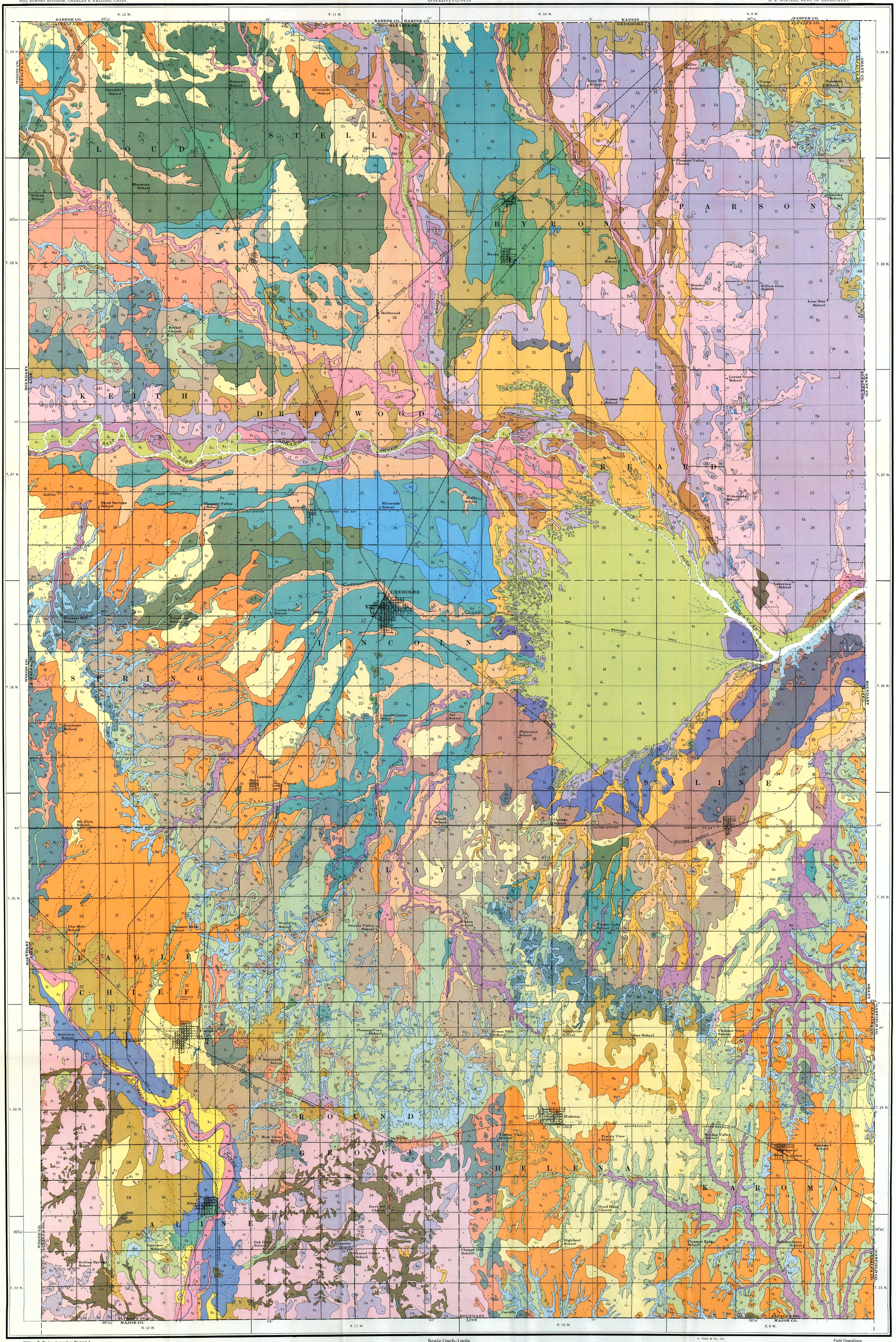
AGRONOMY DEPARTMENT
N. E. WINTERS, HEAD OF DEPARTMENT



LEGEND

Amorita clay loam — Ac	Pratt loamy coarse sand — Pc
Carmen fine sandy loam — Cf	Pratt loamy fine sand — Pl
Carwile fine sandy loam — Cm	Pratt sandy loam — Pm
Drummond very fine sandy loam — Dv	Pratt fine sandy loam — Pr
Enterprise fine sand, Dune phase — Es	Reinach loamy very fine sand — Rl
Enterprise loamy fine sand — El	Reinach fine sandy loam — Rf
Foard clay loam — Fc	Reinach very fine sandy loam — R
Grant very fine sandy loam — Gv	Reinach silt loam — Rs
Kay very fine sandy loam, Saline phase — Kv	Reinach silty clay loam — Rc
Kay silt loam — Kl	Vernon very fine sandy loam — Vf
Nash very fine sandy loam — Nv	Yahola fine sandy loam — Yf
Pond Creek silt loam — Ps	Yahola very fine sandy loam — Y
Riverwash — Rv	Yahola silty clay loam — Ys
Rough broken land, Vernon soil material — RbV	

CONVENTIONAL SIGNS

CULTURE
(Printed in black)

City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort
Secondary roads and Trails
Railroads Steam and Electric
Bridges, Ferry
R.R. Crossings, Tunnel
Ford, Dam, Sawmill, Windmill
Boundary lines
School, Church, Creamery, Cemeteries
Boundary lines
Triangulation station
Boundary monument
Oil or Gas wells
U.S. Township and Section lines
Recovered corners
Forest fire station
Airway beacon
Oil or Gas tanks
Transmission line
Oil or Gas pipe line
Mine or Quarry
Rock outcrop
Made land
Soil boundaries, Stony, Gravelly and Cherty areas

RELIEF
(Printed in brown or black)

Contours
Depression contours
Prominent hills
Mountain peaks
Sand, Wash, and Sand dunes
Bluff, Escarpment, Mine dumps

DRAINAGE
(Printed in blue)

Streams, Springs, Wells, Flowing wells
Lakes, Ponds, Intermittent lakes
Unsurveyed and Intermittent streams
Water pipe lines, Canals, Ditches, Flumes
Swamp
Salt marshes
Submerged marsh
Tidal flats

The above signs are in current use on the soil maps. Variations from this usage appear in some maps of earlier dates.

William T. Carter, Inspector, District 4.
Soils surveyed by A. W. Goke, U. S. Department of Agriculture, in charge, and C. A. Hollopeter and R. E. Penn, Oklahoma Agricultural Experiment Station.

Scale 1 inch = 1 mile
1 ½ 0 1 2 3 4 Miles

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Field Operations
Bureau of Chemistry and Soils
1933